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THE PERMEABILITY OF LIQUID OXYGEN.

In a paper on "The Magnetic Permeability of Liquid Oxygen and Liquid Air," recently presented by Prof. Fleming and Prof. Dewar before the Royal Society, an account is given of the further experiments in their low temperature researches. The work which the authors are carrying on promises that the relation which Maxwell deduced should theoretically exist between the specific inductive capacity, permeability and index of refraction, may be determined experimentally. The method pursued does not directly compare the magnetic permeability of liquid oxygen with that of a vacuum, but with gaseous oxygen at the same temperature, so that the value thus obtained, 1.00287, is a relative one only, but if approximately correct is much nearer to unity than has been quite generally supposed. It also remains to be determined whether this value changes for different magnetizing forces, those in the present case being from 166 to 220 C. G. S. units. The experiments on liquid air show that the magnetic permeability in terms of gaseous air at the same temperature is 1.0024, a value so near that obtained for liquid oxygen, that in all probability owing to the evaporation of the nitrogen present little but oxygen remained. The authors have proposed a method which they believe will enable them to determine the dielectric constant, and with more accurate results obtained for the value of the susceptibility, new means of verifying Maxwell's theory will be at hand.

THE UNDERGROUND CONDUIT SYSTEM IN NEW YORK AND THE RECENT SNOWSTORM.

The rivalry between the forces representing the underground conduit and compressed air systems of street car propulsion in New York City manifested itself in a new form last week. The snowstorm on Dec. 16 caused a suspension of traffic on the Lenox and Lexington Avenue underground conduit lines for the greater part of the day, which gave the advocates of the compressed air system an excellent opportunity, and of which they were not slow to avail themselves, to decry the underground conduit system and laud their own through the columns of the New York dailies. The officials of the Metropolitan Traction Company acknowledge without hesitation that these two lines were practically inoperative, but also state that the cause was not due to any inherent defect in the system. The storm was the most severe of any thus far experienced since the underground conduit system was installed, and it simply developed an extraordinary condition that was not looked for and could hardly have been anticipated. The sudden change in temperature caused a layer or film of ice to form on the underground conductors, which effectively prevented contact between the conductors and plow. When the real cause of the trouble was located a device was attached to the plow for the purpose of scraping the ice from the conductors and thus further difficulty was obviated. Although the conduits were filled with snow for considerable distances, we are reliably informed that there was practically no leakage of current on account of it. Owing to the fact that one of the two generating units employed was shut down for repairs the extra demand for power could not be met, so that several cars were withdrawn from service, thereby adding to the unfavorable conditions. In spite of the efforts, chiefly on the part of the compressed air advocates, to create an adverse sentiment against the electric system, the experiences of last week demonstrate that the success of the underground system is established. If, as it has been asserted, the Lenox Avenue line was installed for the

sole purpose of encompassing the death of the underground conduit idea, the plans of the would-be wreckers have undoubtedly failed. The fact that the Traction Company has practically decided to introduce the same system on other lines can hardly be said to indicate a moribund condition,and the additional fact that the system is thriving leads to the belief that its standing is due to inherent merits rather than to any numerical strength in the directorate of its advocates or opponents.

THE PRINCIPLES OF ELECTRICAL DISTRIBUTION.

The series of articles on "The Principles of Electrical Distribution," by Prof. Crocker, the second installment of which appears in this issue, is especially designed for those desiring a knowledge of the underlying principles in the problems involved in supplying electrical energy for lighting and power purposes. Not a little of the practice of the present day is carried on by the rule of thumb method owing to the fact that the older men in central stations and power plants have not had an opportunity for consistently studying the various phases of electrical transmission and distribution. In these articles an attempt will be made to set forth as clearly as possible the latest practice in transmission and distribution of both direct and alternating currents and the measurement of electrical conductors, their economy and current capacity, and the arrangement and distribution of current and pressure on series and parallel systems, including feeder and main networks. In the present issue Prof. Crocker points out the limitations of Kelvin's law on the most economical size of conductor. There are perhaps few if any empirical formulæ used in electrical engineering which have greater limitations than this so-called law. Its value has in the past been greatly over-estimated. In the transmission of power to long distances the fundamental question is a financial one, thus putting the problem in the form of obtaining the maximum ratio between the income derived from the power delivered to the cost of generating and transmitting. The question, therefore, remains to determine how much energy will be immediately utilized and the prospects of future requirements, and so under the specific conditions presented, calculate in a manner similar to that pointed out by Prof. Crocker, the size of conductor which will permit of the best regulation under the most economical conditions.

THE EFFECT OF MUNICIPAL CONTROL IN ENGLAND.

The reckless advocates of municipal control in this country who fail to heed the results of experiments thus far made in this direction, might do well to study some of the effects abroad. A good illustration is to be found in the recent proposal of the Bristol Tramways Company, Bristol, England, to operate its entire system by electricity. The company has at present part of its system electrically equipped and desires to effect a complete change by abandoning the present horse-car service. This the Electric Lighting Committee of the Town Council has granted upon the condition that power for the extension be obtained from the already-existing alternating-current city lighting station, a proposition to which the Tramways Company replies by stating that it would prefer to retain the present horse-car service. The Committee on Lighting has retained Mr. Preece as expert adviser, who has submitted a report which for incongruous statements is most noteworthy, while the Tramways Company has had favorable communications from Lord Kelvin and Dr. John Hopkinson, both of whom have endorsed the report of the company's expert. The chief desire of the Bristol Town Council is apparently to derive sufficient benefit by supplying power to the Tramways Company, already a paying property, to help the municipal plant out of its present unprofitable condition. Thus it will be seen that British engineers have not only "official science," but "town councils"—in this instance, strange to say, practically one and the same—as a bane to their endeavors. Our London contemporaries have taken an excellent position in the matter, a position which, if strenuously adhered to, may ultimately effect a revolution in the minds of Britishers so long invested with the plague of municipal control.

RÖNTGEN RAYS AND THEIR RELATION TO PHYSICS

Although no radically new ideas were presented in the Institute discussion Wednesday evening, Dec. 16. on "The Röntgen Ray and Its Relation to Physics," the meeting was most entertaining for the manner in which the developments thus far made were reviewed and compared. Both Prof. Rowland and Prof. Thomson dwelt upon the little that was known regarding Röntgen rays and the little that could be said, but judging from the scope of their remarks it was much as Prof. Pupin suggested—What would they have said had they known more? Prof. Rowland believes that much of importance lies in the discovery that Röntgen rays possess the property of discharging both negatively and positively electrified bodies. This phenomenon, although differing from that of light, inasmuch as ultra violet rays have been found to dissipate negative charges only, yet may ultimately be reconciled with the latter. Batelli and Garbasso have found, however, that air, after having been acted upon by Röntgen rays, possesses the power of discharging electrified bodies, a property as yet unobserved in the case of ultra violet light so that another discrepancy is introduced. The results thus far obtained in the regular reflection of Röntgen rays seem to have been received with but little credence, and Prof. Rowland stated that he had doubts of its existence. This view is in accord with the theory that Röntgen rays are of extremely small wave-length, so that no substance may exist, no matter how highly polished may be its surface, which would be of sufficient density to produce, by any means at present at hand, regular reflection in a measureable degree. By a method of producing a "monochromatic" radiation by "filtering" out radiations of more than one order, it is quite possible that the same conditions may be repeated at pleasure, and that various experimenters will thus have a definite basis upon which to compare the results of their investigations. As it is at present, considerable controversy exists and many disputes arise regarding the results claimed, when neither party knows the conditions under which the other was working. We believe, as previously alluded to in these columns, that Mr. Porter has made the most explicit demonstration in classifying Röntgen rays of different properties, notwithstanding the crude and perhaps illogical method of distinguishing one prominent type from another. By adopting a method similar to that proposed by Dr. Pupin, of substituting a spherical mirror for the cylindrical mirror used by Prof. Rood, diffused and regularly reflected radiations may possibly to a large degree be separated, and thus the existence of the latter more definitely determined. We believe that the statement made by Dr. Kennelly in the course of his remarks, to the effect that an attempt should be made to co-ordinate the results of Röntgen ray experiments with the prevailing theories of light rather than to adopt new theories for the purpose of seeking an explanation of the various phenomena which they exhibit, deserves endorsement. It is not unreasonable to suppose that light and Röntgen rays may be one and the same phenomenon, yet differing from each other in their properties as do light and heat.

The Brighton-Rottingdean Railway.

Our English correspondent informs us that the amphibious electric line of Mr. Magnus Volk, was, prior to its opening on Nov. 28 last, submitted to a most severe test by a representative of the Board of Trade, but, notwithstanding this fact, Dame Nature has imposed a more difficult task upon it, with the result that more than $20,000 damage has been inflicted, including the destruction of one of the jetties, the complete wreck of the car, now lying on its side on the sands, and the wholesale destruction of the track.

Meeting of the American Institute of Electrical Engineers.

The 110th meeting of the Institute was held at 12 West Thirty-first Street on the evening of Wednesday, Dec. 16. The subject of the discussion was "The Röntgen Ray and Its Relation to Physics." President Duncan occupied the chair and some 100 members and guests were present, many having come from distant points outside of the city. The discussion was opened by Prof. Henry A. Rowland and was participated in by Prof. Elihu Thomson, Dr. M. I. Pupin, Dr. A. E. Kennelly and Mr. Max Osterberg. A communication was also received from Prof. W. M. Stine, of Chicago, on the "Generation of Röntgen Rays."

Prof. Rowland, in opening the discussion, stated that there was little new to add to the very complete experiments of Prof. Röntgen, and there remained, therefore, little for him to do but to review the work up to the present point. He stated that Lenard perhaps first discovered the rays, but failed to recognize the distinguishing difference between the rays bearing his name and those of Röntgen. Röntgen had pointed out that any point acted upon by the cathode discharge became the source of radiation. Prof. Rowland stated that he was not aware that any conclusive demonstration had been made that regular reflection exists, and has doubts of its existence. There is no evidence of polarization, although some have claimed such to have been found, while others have failed to verify these experiments. One of the additions to the work of Röntgen was the discovery of Becquerel, that rays emanating from fluorescent substances exhibited properties similar to those of Röntgen rays and yet were undoubtedly ultra violet light. Prof. Rowland considers that the most important contribution since the discovery of Röntgen was that of their property of discharging electrified surfaces, found by Prof. J. J. Thomson, and that surfaces acted upon by the rays for the time being become partial conductors. He stated that most people connected Röntgen rays with bones and when they wish to make a demonstration of any of their properties they include bones for this purpose. For his part, he believed that there existed a better field for experiment than in this direction. He was satisfied that Röntgen rays are not homogeneous, and that they can be filtered through different objects so that they may be separated. He expects to find a filter which will show the properties of one type of ray only. In regard to the theory, he said that we were at one time satisfied that we knew something regarding the nature of light, but Maxwell had completely upset these theories and Hertz had proved experimentally that light was simply an electromagnetic phenomenon. These discoveries caused great complications in the theories of the ether, so that our minds have become in a whirl and we are compelled almost to give up reasoning regarding them. Röntgen's discovery still more complicates the situation. One thing is certain, we can obtain a limit to the wave length, and as he stated in a communication to THE ELECTRICAL WORLD last Spring, the wave length was at least one seventh that of yellow light, others, however, having obtained one thirtieth. He is doubtful if interference bands exist, and whether the same have ever been shown as has been claimed. If the wave length was infinitely short, no substance would answer for demonstrating either reflection or polarization. The shorter the wave length the more, in his opinion, should Röntgen rays be dispersed, and such waves cannot, according to Maxwell's theory, be polarized. It is not impossible, he believes, that the ether is incompressible, and such would be the case if we left out of consideration the closed lines of induction which form the fundamental hypothesis of Maxwell's theory. He mentioned Stokes's theory, in which it is advocated that the rays consist of single impulses of very long periodicity, but he thinks that the Röntgen rays must be a series of waves of very short period. He referred also to Michelson's theory of vortex rings, but he could not imagine how such a condition could exist in a perfect fluid. He concluded by saying that we cannot expect to have a theory of Röntgen rays in a single year.

Prof. Thomson continued the discussion by stating that he agreed with Prof. Rowland in the statement that we know little about the rays, and the more facts we accumulated the more our ideas became confused. He did not believe with Prof. Rowland that the surface struck by the cathode rays cannot become the source of Röntgen rays, but had found that, with tubes with which he had experimented, any surface acted upon by the cathode rays did become actually a source of Röntgen rays. He stated that this may be explained by assuming that the surface struck became an anode by induction, but whether an anode or not, the fact still remained. Glass, he found, became a source from which radiation takes place in all directions. If the vacuum is very low the rays are not produced. All apparatus he found worked about equally well if properly handled. He stated that the Holtz machine gave an intermittent discharge of a very high rate, and considers that it is one of the best means of exciting the tube. He found that the most effective method of excitation was that arranged by Herman Lemp, in which a 12-inch inductorium was used, the primary of which was excited with an alternating current of 125 periods per second, the secondary giving under this condition a continuous arc of from five to six inches. Now, by inserting in series in the secondary circuit a rotating commutator running in synchronism with the alternating primary current, he was able to pick off the tops of the alternating current waves, and thus obtain a unidirectional or pulsating discharge. This method when arranged properly gives an exceedingly uniform discharge of 125 pulsations per second, but unless handled in a careful manner will be found to melt and destroy the platinum reflecting surface within the tube very quickly. In one case he found that with a vacuum tube having electrodes at either end and a platinum reflecting surface at an angle with the direction between the electrodes, this reflecting surface became pierced by the cathode discharge, and although the surface had a backing of platinum for the purpose of support, the cathode discharge passed completely through and intensely heated the anode at the opposite end of the tube, thus showing the high penetrative powers of the cathode discharge. This tube produced an exceedingly fine shadow on the fluorescent screen, and when the vacuum was very high and no fluorescence on the tube existed, it was found that the Röntgen rays were capable of penetrating 3 16ths of an inch of iron, and at the same time cast a strong shadow on the screen. The screen was more luminous when the vacuum was higher. It was also found possible to penetrate ⅜ of an inch of wrought iron plate located 6 inches from the platinum surface, and two plates of cast iron each 9/16ths of an inch thick allowed the rays to pass through, but no shadow could be obtained on the screen, as the rays were greatly diffused. He believed that a great many rays strike the surface of the tube and are there stopped, so that the rays getting through still retain the property of penetrating other objects, such as glass or iron. He agreed with Prof. Rowland and believed that it was almost universally accepted that Röntgen rays are non-homogeneous in their character, whether the same be due to a difference of wave length or anything else. Low-vacuum tubes, inoperative by a silent discharge, may be made active by using a condenser and spark gap. He found that with one spherical tube in which the electrodes were placed directly opposite one another and a wedge of glass inserted in the centre of the tube that the surface of the wedge farthest from the cathode was the surface which was the source of Röntgen radiation, thus showing a peculiar phenomenon contrary to general conditions. He thought that it would be possible to separate one type of Röntgen rays from another by a method similar to that of obtaining different colors of light, by allowing the rays from the tube to fall upon, say a block of paraffine, and then be diffused at right angles to their first direction on to a surface of wood, again being diffused at right angles or parallel to the first direction on to a fluorescent screen placed opposite the tube, but screened from the direct action of the tube by a metal partition. Now, by transposing the wood and paraffine, the difference between the first and second diffusing actions on the screen can be noted, and in this way by substituting different materials, perhaps separation of the different rays could be obtained. Prof. Thomson does not believe that the effect on the tissues produced when experimenting with Röntgen rays is either ozonic or electrostatic in its nature, but is due to the direct action of the rays themselves, the rays producing the action being those of the lowest order. In other words, if we could screen these lower order rays from the others, no deleterious effect on the tissues would be produced.

In continuing the discussion Dr. Pupin dealt chiefly with three points. First, the method of operating the tube; second, the reflection of Röntgen rays, and third, the Helmholtzian theory of electromagnetic dispersion and of the bodily motion of ether and their bearing upon the nature of Röntgen rays. He believes that in the reflection of Röntgen rays the only satisfactory method will be that in which regular and diffused reflection are separated, and prefers to use a spherical metal mirror for this purpose. By placing the tube slightly upon one side of the axis of the mirror, the diffused and reflected rays will be brought to different foci and could be studied separately. He believes that the Helmholtzian theory compels us to consider every molecule as composed of a very large number of atoms. Hence a molecule has as many periods at least as it has atoms, but the amplitude of

vibration of any particular frequency depends on the manner of excitation. Slow impulses, such as take place at low temperatures, favor the lower periods, while sharper impulses, such as may be obtained at high temperatures, favor higher frequencies. If the cathode rays are really negatively charged exceedingly minute particles moving at very high velocity, then their impulses on molecules would be in all probability the sharpest kind of impulses yet obtained, and therefore it would make the higher frequency vibrations in the molecules most prominent. If, therefore, the Röntgen-rays are transverse vibrations, then we should infer that they will be accompanied by other short-period vibrations, not too short for polarization, refraction, etc., but shorter than any other vibrations that have yet been obtained.

Dr. Kennelly then continued the discussion by stating that he believed that the bombardment theory of air was to be questioned and substantiated this belief by placing a Crookes radiometer in the path of the rays, one half of the tube parallel with the axis of the vanes being shielded by a metal screen. No movement of the radiometer was noticed when the tube was excited and rays were being produced. He believed that certainly some movement would have been noticed had the vanes been acted upon by moving particles. He also stated that there was no doubt that there existed an effect produced by Röntgen rays similar to that of sunburn. In reference to the action of the rays on the blind he said that where blindness consists of a destroyed eyeball no perceptible effect was produced by the rays on the subject, but when the eyeball is in good condition and the optic nerve only is defective the rays are highly perceptible. When the cornea is affected the rays produce the effect of light and darkness, but there is not sufficient evidence to show that the cornea acts as a fluorescent screen. He stated that he considered it preferable to adhere to our existing theories of light, and try to explain our experiments with Röntgen rays with their aid rather than adopt other theories that were new and not sufficiently warranted.

Mr. Max Osterberg, in continuing the discussion, referred to the rotating commutator method of exciting induction coils and the better effects produced by having a long make and an exceedingly short break.

Prof. Rowland, in conclusion, stated that he had tried placing an isolated surface in a vacuum tube and having the same acted upon by the cathode rays, and contrary to Prof. Thomson's results, had obtained no effects whatever. He did not believe that there was any necessity for trying to introduce, as Dr. Pupin had done, a theory of a movable ether, in fact, he did not understand how a part of the ether could be moved without moving the whole, and he did not see how we were going to move the whole with any powers which we were able to command.

Mr. Mailloux introduced a resolution thanking the "foreign" members for having been so kind as to come such long distances to participate in the very enjoyable discussion of the evening. The motion was unanimously carried and the meeting then adjourned.

Electro-Chemistry.

Mr. Bertram Blount read a paper recently before the Northern Society of Electrical Engineers, England, on the subject, "The Preparation of Alkali and Bleach by the Chemical and Electrical Methods." Mr. Blount, according to our English correspondent, arrived at the conclusion that, from the point of view of the expenditure of coal, the electrical process is the more economical, though mere economy in coal does not settle the question. He was of the opinion that as time goes on electricity will gain upon the present chemical processes on account of its greater directness, cleanliness and absence of obnoxious life-products, and the diminution of the part played by the manual laborer. As to the latter factor Mr. Blount remarked that any process which tends to its "deletion has a commercial advantage."

Becquerel Rays.

In a communication to the Academy of Sciences M. H. Becquerel states that after eight months in complete obscurity, the radiation from uranium and some of its salts remains unchanged. The rays emitted by uranium and its salts have some properties in common with Röntgen rays, but differ from them in being reflected and refracted like light. The property of discharging an electrified body, which is communicated to a gas by exposure to Röntgen rays or by transmitting electric sparks through it, is also possessed by air after having passed over uranium in the dark.

On the Cathode Rays and Their Probable Relation to the Röntgen Rays.

The following communication was presented before the Deutschen Naturforcher Versammlungen at Frankfort-on-the-Main, in September last, by Prof. Lenard, and published in the London *Electrical Review*:

The cathode rays, as produced by the electric discharges in gases, have long been known. To these a new kind of rays with kindred properties has been added by the recent discovery of Röntgen. The properties of these newly discovered rays appear in the light of the present state of knowledge to be in agreement with the hypothesis that they are essentially a limiting case of the cathode rays, namely, cathode rays with infinitely small magnetic deflectibility. Röntgen rays, according to our hypothesis, would consist of the same ether processes as the cathode rays, but with a special value or series of special values of one of their parameters. What points to this kind of theory will now be indicated. By cathode rays are to be understood such rays as proceed from the cathode in a discharge tube.

In the first place, it is to be noted that we already are acquainted with an unbroken series of different kinds of cathode rays which differ only in the amount of their deflectibility by a magnet, just as different kinds of light are distinguished by their refrangibility in a certain medium. The deflectibility of a cathode ray remains the same throughout the whole of its course, be the gaseous or solid media through which it passes what they may, just as the color of a light ray remains the same in analogous conditions. The case of fluorescence is an exception in the case of light, and Röntgen's discovery has supplied an analogy to this in the case of cathode rays, namely, the conversion of cathode rays of finite deflectibility into rays of imperceptibly small deflectibility by the action of ponderable matter.

Cathode rays of very great deflectibility and all intermediate shades down to the comparatively small deflectibility, can be produced in discharge tubes. The lower the gas pressure is in such tubes, and, therefore, the greater the electric forces which act upon the gas, by so much the smaller is the deflectibil'ty of the rays produced. The smallest attainable deflectibility is reached by the application of the greatest electrical forces.

The known kinds of the cathode rays have, so far as I have been able to prove it, the property of being absorbed by ponderable matter approximately in proportion to its density. That is to say, in so far as the amount of the absorption is determined by the medium, it is about twice as much for a medium of twice the density. This property, being independent of the amount of deflectibility, appears to be a characteristic property of the cathode rays. It is, as is well known, also a property of the Röntgen rays.

The different kinds of cathode rays have properties which vary gradually with the amount of their deflectibility in the following way, so far as quantitative experiments have been made: The less deflectible a cathode ray is, the less will it be (1) absorbed by passing through a ponderable medium; the less will it be (2) dispersed by it, that is to say, the less turbid is the material to it. This relation has been found to hold for cathode rays which issue from discharge tubes with thin windows, and which, as experiment shows, contain only minute traces of Röntgen rays, the window being very thin. It is evident that with cathode rays of infinitely small magnetic deflectibility both the absorption and the dispersion is indicated to be small by our hypothesis. Just these are the properties of the Röntgen rays.

Further properties of the cathode rays in relation to their deflectibility have not yet been investigated. It is probable that the accurateness of our law of absorption for each medium, is also a function of the deflectibility of the rays. Common to all kinds of cathode rays and to Röntgen rays is the property of making gases conducting, and also the allied property of facilitating the formation of fog. Common also to all these rays is the property of exciting phosphorescence and chemical action.

From what has been stated above, the existence of a gradual transition from the cathode rays to the Röntgen rays appears to be probable. On the other hand, Lodge and J. J. Thompson have pointed out the possibility of a gradual transition from the Röntgen rays to the optical spectrum through the region of the rays recently discovered by M. Henri Becquerel.

Finland in the Lead.

The small town of Marieham, in Finland, takes the lead as the best telephoned town in the world, there being one telephone to every 13 inhabitants.

Electricity in the Weather Bureau.

THE electrical instruments in use in the United States Weather Bureau in the Manhattan Life Building in New York City, possess electrical features which are of considerable interest. Many of the applications, while somewhat complicated, are ingenious, and electricity has been the means of recording and transmitting observations which it would be impossible to do by any other means.

The principal instruments in which electricity is an important factor are the telethermograph, the sunshine recorder, rain gauge, the anemometer and the vane. The telethermograph is located in the instrument shelter which is mounted on a high trestle at one corner of the building. This shelter as seen from the dome is shown in the initial illustration. It is simply a housing of metallic slats slanting on each other after the fashion of the ordinary window blind, with a second protection of wooden slats in reverse position inside. It is reached by a spiral stairway which leads down to the roof. The principle of the operation of the telethermograph is as follows: A bent tube very much like a Bourdon gauge tube is filled with alcohol, and by the expansion of the alcohol due to a rise in temperature, the pressure causes the tube to straighten. A system of levers is connected to the tube and moves a little index over a scale which is graduated to read in degrees. Underneath the moving index is a secondary index on which are mounted two pins which project forward and include the primary index. Assuming that the temperature goes up, the primary index presses against one of the pins of the secondary index and closes an electric circuit. A magnet promptly hitches the secondary index forward a quarter of a degree. If the temperature still continues to rise contact is made again and the operation is repeated. A similar action takes place in case the temperature falls. The circuit leading to these pins is therefore an interrupted circuit and is led off the bottom of the building where the recording instruments are placed.

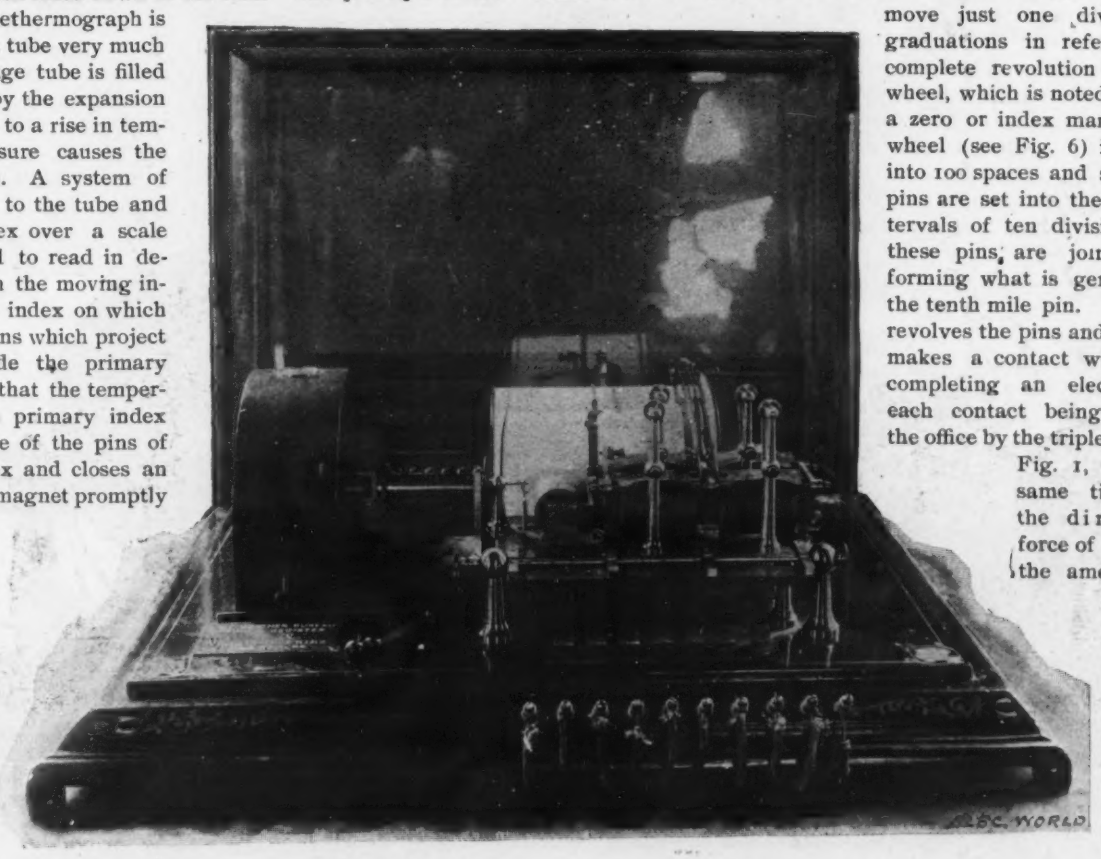


FIG. 1.—TRIPLE SELF-REGISTER FOR WIND VELOCITY AND DIRECTION, AND SUNSHINE.

The recording instrument consists of a drum driven by clockwork upon which is placed a sheet of paper. The two circuits from the telethermograph are brought into the recording instrument and act differentially on the motion of a needle. If one acts continuously the needle will rise and if the other acts it will fall. From this it may be seen that the needle will follow the motions of its prime mover in the shelter, and will record those motions by a wavy line on the drum which is suitably laid off in degrees and fractions thereof. The mechanism actuating the recording instrument is driven by clockwork and is released electromagnetically. Fig. 5 shows the telethermograph, and Fig. 2 the recording end of the system.

The sunshine recorder is an interesting little instrument and gives a record of when the sun shines and when it is obscured. It consists of a glass tube with a bulb blown on each end, the whole enclosed in a protecting glass sheath which is perfectly exhausted of air and sealed. These bulbs are as nearly equal as may be in cubical contents. One bulb is thoroughly blackened and the other is left clear. In the tube connecting them is a thread of mercury, and if the air in one of the bulbs is expanded more than in the other the mercury thread will follow in obedience to the more powerful pressure. About the middle of the tube the mercury thread encounters and encloses a pair of contacts which are in electrical circuit with the recording instruments which will presently be described. It will be seen at once that a great difference in temperature of the air wil affect both bulbs equally and the mercury thread will not move, but should the sun shine, the absorbent effect of the blackened bulb will quickly raise its temperature and move the thread forward so that contact is made.

On the shelter are two other instruments which record their results by electrical means; the vane which shows the direction of the wind makes eight different contacts in a complete revolution and these circuits are led off to the same recording instrument that registers the record of the sunshine recorder. The anemometer consists of the cups, spindle, and dial mechanism; the spindle forms the axis of revolution of the cups, and has a worm or endless screw near the lower end; this screw engages a wheel of 50 teeth, upon the axis of which is another worm or endless screw similar to the first; the second worm imparts motion to a small pinion which in turn gives motion to a pair of dial wheels having 100 and 99 teeth respectively and graduations to correspond. The wheel having 99 teeth must therefore go one notch more than a complete revolution of the outer dial which has 100 teeth. This causes the lower wheel to move just one division of its graduations in reference to the complete revolution of the outer wheel, which is noted by means of a zero or index mark. The dial wheel (see Fig. 6) is graduated into 100 spaces and small contact pins are set into the wheel at intervals of ten divisions; two of these pins are joined together forming what is generally called the tenth mile pin. As the wheel revolves the pins and long contact makes a contact with a spring completing an electric circuit, each contact being recorded in the office by the triple self-register, Fig. 1, which at the same time registers the direction and force of the wind and the amount of sunshine in hours and minutes. It will be seen that the notches on the outside wheel represent the miles and tenths of a mile, while on the inside wheel, tens and hundreds are recorded, the dial re-setting itself at zero after 999 miles are made.

A little thought in connection with the foregoing in regard to the train of gearing, and number of teeth in the various wheels, will show that 50 revolutions of the cups will be required to move the outside dial one tenth, and 500 turns will move it 10 divisions, or

what has been found to represent an actual wind movement of just one mile.

A spindle with a worm or endless screw near the lower end rotates a wheel such as is shown in the illustration, Fig. 6, by means of a system of multiplying gears. Pins are placed at mile intervals on the rim.

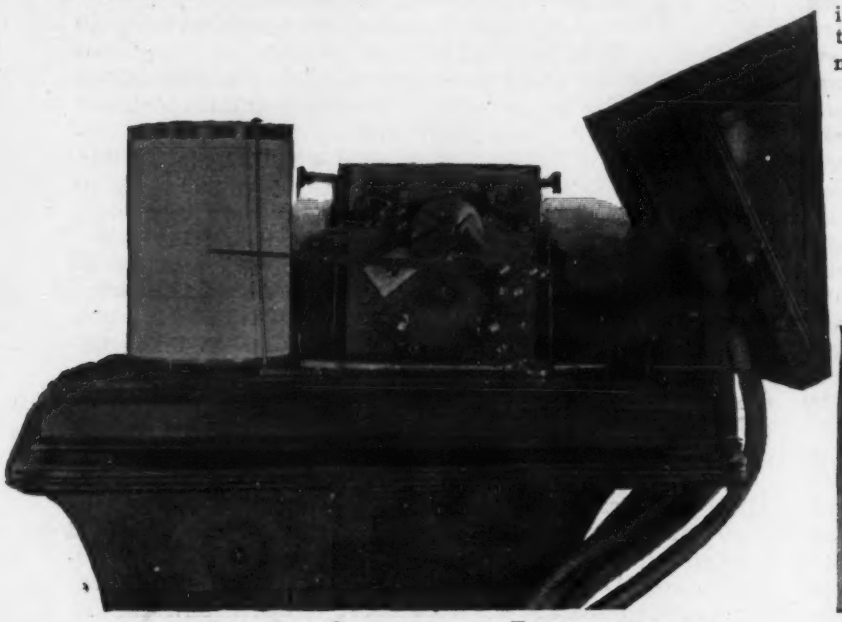


Fig. 2.—Recording Instrument for Telethermograph.

The drum shown in Fig. 1 is rotated by clockwork and is later ally moved by running on a cross spiral which causes the drum to make four turns in 24 hours. The records are therefore on spiral lines on the drum, and when the sheet is taken off the latter, the records proceed across it at an angle. Four fingers with inking markers at their termini indicate the direction of the wind. There are four letters, *N*, *E*, *S*, and *W*, and if the wind is in any of these four directions a row of dots will be made opposite the corresponding letters as the drum proceeds. If the wind is northeast two rows of dots will be made, one opposite *N* and the other opposite *E*, and similarly for the other points of the compass midway between the four principal directions. These markers do not trail on the surface of the drum all the time, but are periodically moved by a contact in the clock, which closes the circuit every minute; thus the dragging effect of these indexes is negligible.

Two other needles record upon the drum. One is actuated by a magnet which is in the anemometer circuit and, of course, makes its mark whenever the anemometer makes contact. The distance between the marks is inversely proportional to the speed of the wind at that time, for this drum has a chance to travel further when the mile is made slowly than when the speed of the wind is higher. The sunshine recorder circuit actuates a magnet which operates another index on the drum. It is closed every minute by the clock. If in the tube the circuit is closed, the closure of the circuit by the clock makes a record on the drum at minute intervals, and if it is open no record is made. Thus the absence of a record indicates cloudiness and the presence of one indicates sunshine. This instrument, as shown in Fig. 1, although at first sight appears somewhat complex, it is really quite simple. The rain gauge is a no less interesting and ingenious application of electricity to automatic recording devices. An ordinary rain gauge is mounted on a scale or balance beam, and if rain falls in the gauge it will descend and close an electric circuit in which is placed an automatic interrupter. This interrupter works two magnets, one of which is directly on the rain gauge and the other is in the receiving instrument. The action of the magnet on the gauge is to operate a ratchet wheel which in turn slides out a weight, thereby balancing the weight of the rain that has fallen in the gauge. When the beam is exactly balanced it rises and of course contact ceases and cuts off current from the magnets. The position of the weight on the scale beam indicates the amount of water that the receiver contains, but instead of being graduated to read in pounds, it reads in inches of water. The magnet in the recording room operates an index which registers on a revolving drum. This index slides on a rod provided with a double thread, and the rod is operated by a ratchet and magnet mechanism similar to the one on the main gauge itself. The motion of the rod clear across the drum indicates 0.5 of an inch of water and the distance is divided into hundredths. As the magnet works the pen plays to and fro, until the full amount of rain that has fallen is recorded. To read the record, the number of times the index has traveled back and forth is multiplied by 0.5, and to this is added the actual indication of the gauge at the time. The drum is driven by a clock within it. The

Fig. 3.—Rain Gauge.

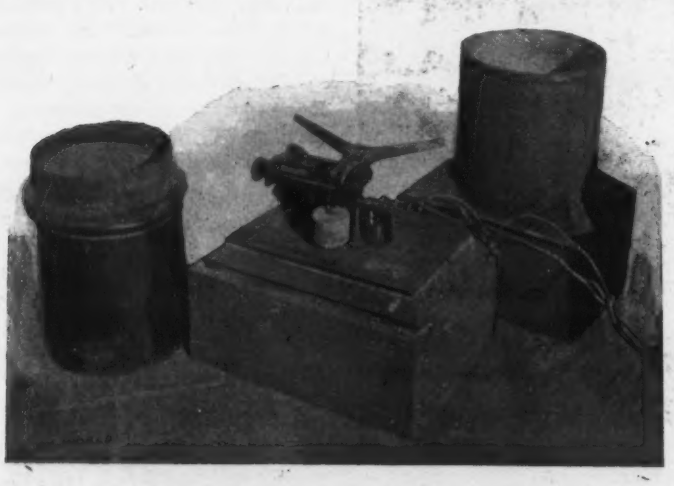


Fig. 4.—Rain Gauge Recorder.

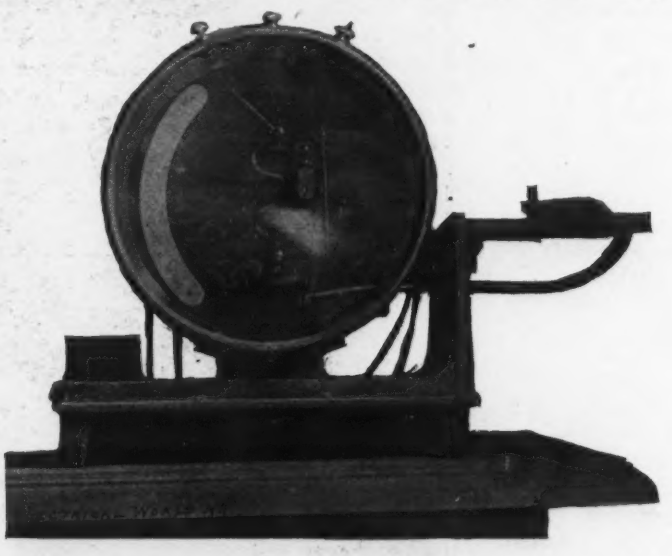


Fig. 5.—Telethermograph.

clock turns the axle which protrudes from the ends of the drum, and as this is clamped to the support, the drum and its clock must revolve. The rain gauge itself is the subject of Fig. 3, and the recorder to which it delivers its impulses is shown in Fig. 4.

Besides these special instruments the telephone and telegraph play a most important part in obtaining the observations of the weather bureau. Stations are, of course, placed in communication by these means of transmission, and are continually exchanging observations

FIG. 6.—DIAL WHEEL OF ANEMOMETER.

so that the storm centres can be accurately located, and the direction and velocity of any atmospheric disturbances can be obtained, and from these records a forecast that has a reasonable degree of probability can be made. Without the aid of electricity the weather bureau would be practically helpless, and of but little value to any one except scientists.

Production of Röntgen Rays.

In a recent communication to *Nature*, Prof. Oliver Lodge, in referring to the experiments of Mr. T. C. Porter, in which a Wimshurst machine was employed, states that the difficulty in obtaining Röntgen rays with a steady current and low vacuum may lie, to a large extent, in the fact that the machine will not work well when short-circuited. Machines with permanently charged armatures do not suffer from this defect, but it appears that a given quantity of electricity supplied in "jerks" is optically more effective than the same quantity delivered smoothly. This fact he has, however, not been able to verify photographically, and therefore believes it a physiological rather than physical condition.

American Turbines in England.

The largest water turbines in England have recently been installed at Bradford. They were made by a well known American concern, and are, according to the Hon. Claude Meeker, United States Consul at Bradford, giving perfect satisfaction.

Insulated Wires and Cables, Their Construction and Design —Insulation; Its Efficiency and Defects.

BY J. DRAPER BISHOP.

(*Concluded from page 775.*)

The cable is then passed through the blocks from the nozzle end until it appears through the die at the other, the pressure is turned on, the ram rises and forces the cylinder of lead up against the ram, thereby squeezing out the plastic lead through the die, which in its passage grips the cable and automatically hauls it through the blocks, from whence it emerges lead covered, and so hot that the men have to handle it with gloves or their equivalent as they coil it up on the reel for delivery when cool.

This is continued until at length the lead ram having penetrated to the bottom of the lead cylinder, the pumps are shut off and the pressure reversed, the hydraulic ram, blocks and lead cylinder consequently being lowered until a space of an inch or so remains between the top of the lead cylinder and the lower surface of the lead ram. The lead cylinder is once more filled, raised up to the lead ram and another "wait" followed by another period of action ensues and this process is repeated until the covered cable is complete—the points where the new charge meet the preceeding one being shown on the cable sheath by a slight annular mark.

The rate of work will depend on the size of the cable to be covered and the thickness of the pipe and will vary in speed from 3 or 4 for heavy to 300 or 400 feet per minute for the smallest kind.

The "blocks" here described are by no means representative of the best or most scientific design; on the contrary, they are of the most antique and crude form known, but when once made, as they never wear out under fair treatment, they still remain in use rather to prove the survival of the "most ordinary" than of the best and fittest. In fact the whole arrangement described above is antiquated, clumsy, slow, risky, involved and altogether out of date. As it was in the beginning, so it is now, and if there is one branch of applied science and manufacture in which petrified stagnation and stolid indifference to advancement show us in America how much we excel others in spite of our boasted "up-to-dateivity," it is in the matter of lead presses and their adjuncts.

First, steam power is required to work the pumps—loss first.

The pumps force water into the hydraulic cylinder and raise the ram—loss second.

The ram blocks and cylinder are then carried upward with irresistible force, until the lead ram forces the lead down again and out of the dies—loss third.

The cylinder blocks and hydraulic ram are then lowered slowly into their original position—loss fourth.

These four losses are as to power only.

In time:—the press takes about three minutes to empty the lead cylinder of its charge. To lower it, refill cylinder and cool off will occupy nine minutes more.

Thus there are consumed nine idle minutes to three active ones—or, in other words, the press and all hands are forcedly doing nothing for nine months during the year, while wages, coal gas and all expenses are the only things running.

But the employers don't grumble, the hands like it, and the machine says nothing. To look at one of those elephantine machines with all its complicated services and tons of metal, brought to bear on a pitifully small quantity of plastic lead so soft that a carving knife will cut through a two-inch pipe like butter, is enough to make any progressive man or engineer, with a mind trained to enjoy the general and relative fitness of things, ill with anger and disgust. A better machine can be made to do the same work at one fourth the cost in dollars, with one fourth the power and a saving of 300 per cent. in time.

But, thanks to monopolies and trusts and their merciless grasp on and control of any poor man's invention of value, patented or unpatented, with or without his consent, the day when America rewarded and developed ingenuity, industry and originality has passed away into the background of memory, and there remains not even a shadow of the prestige which once placed American inventions and inventors first in the ranks in the whole wide civilized world of applied mechanical and constructive art.

INSULATION—INSULATION TESTS AND THEIR VALUE.

I once heard an electric light construction foreman define insulation as "Blank's tape, for there ain't no other as is good for nothing." Probably he meant the reverse of what he said, and therefore might be considered too prejudiced to be a good judge.

That was in Chicago, however. But a Boston foreman's definition of an insulator as "a sort of white china door-knob with a hole through it," if less vague, is certainly more popularly accepted.

These men were only subordinates, however, and probably knew less than their chiefs.

But when the manager of one of our electric light concerns states that "galvanometer tests for insulation were taken every day, but capacity tests never, because they knew exactly how many lamps they had in circuit," one is reluctantly forced to conclude that even those who should be better informed have not yet emerged from the "wooden bead and china door knob" state of lamentable ignorance of first principles. And, indeed, one has but to look at line work in any of the streets and avenues of even our leading cities, to see such reliance placed on the frailest kind of insulating or constructive means, as would make any European foreman shudder. Wires carrying how many volts only those concerned can approximately judge, probably thousands, are "insulated" by a covering of compounded braid more or less ruined by exposure, and often hanging in strips, thereby being more dangerous than bare wire, or "insulated" from approximate line, guy or stay wires, by a wrapping of tape, or mechanically separated from each other by a small "door knob," in a manner that betrays not only ignorance, but a loose, "good enough," slipshod style of construction where carelessness is carried to the point of criminality.

But so long as the current passes and the lamps burn it's "good enough." Coal is cheaper than skilled labor, and it amuses the public on wet nights to watch small blue streams of fluid creeping about arms and brackets carrying the Blank E. L. Co.'s wires. This is one of the results of a failure to understand the inner principles of insulation, and when these are more thoroughly mastered wires now covered with so-called "weatherproof insulation," which is neither weatherproof nor insulation, will be used bare, and many wires now practically worse than bare will be well and properly insulated and put underground.

If there be one part of an electric light or power installation in Europe which attracts the attention and should compel the admiration and emulation of the American engineer, it is the minute and conscientious care bestowed on the insulation of every detail of the circuits, both indoor and out, and it is really a matter of deep regret that American practice, which shines so conspicuously in theory and holds such a front rank in apt design and effective construction indoors, should in outdoor work still retain methods so contemptibly cheap and meanly inartistic.

When I admit that there are probably more arc lights in one of our avenues than there are in all the cities of Great Britain combined, it is not by way of apology for this state of things here, but, on the contrary, to emphasize the fact that there is consequently all the less excuse for it.

The quicker we emerge from this "tape and door knob" darkness into the light of sound construction work the better for all concerned. Coal bills will be less, maintenance cost will decrease, fatal accidents will be fewer, and, perhaps, most important consideration of all, dividends will be greater.

The term "insulation" is ordinarily used and accepted as a quality in a cable having an absolute value in terms of some deflection obtained on a reflecting galvanometer, which indicates in a more or less definite manner a certain number of units of resistance, generally reckoned by the million, tens, hundreds or thousands of millions of ohms.

In no other branch of engineering science has such refinement and delicate ingenuity been brought to bear as on the construction and manipulation of the reflecting galvanometer and its various accessories, and in no other branch of any practical science have such elaborate installations and calculations been tortured into producing results and decisions, mathematically correct, I admit, but practically, I am bound to say, worse than useless, because misleading; in fact, in so far as electric light and power cable insulation is concerned, it would be no loss if every galvanometer, shunt box, resistance coils and all the rest of the glittering paraphernalia were thrown into the sea.

For such delicate work and minute currents as those required for telephone, submarine telegraph and laboratory work, where the current is measurable only in infinitesimal fractions of a milliampere, they are often indispensable and fulfill their purpose admirably, as does the delicate assay balance in its sphere. But no engineer would dream of testing the strength of a bridge girder by noting through a microscope the deflection caused by an ounce weight and from multiples of this by the million, define its strength or breaking weight in tons. And yet that is equivalent with what we do when we apply the galvanometer indicated ohm test as a measure of the "insulation" of a cable. In either case the indications and their calculated result are fallacious.

The writer has for years been trying, in the face of much opposition and discouragement, to force this doctrine upon those interested, but without much success so far, and even now it is only within the charmed circle of the inner 400 of the electrical world that the old traditions of the galvanometer are losing their hold on the esteem and veneration hitherto surrounding them.

The consumer's engineer, under the influence, perhaps, of favorable report or a special predeliction for some particular make of cable, unsupported either by experience or reason, selects it as best suited for his purpose, believing honestly that his employer's interests will best be secured thereby because he is told that this maker's cables give such "a splendid insulation test, higher in fact than any other cable made." And this decides the matter as being conclusive proof of superiority in current-carrying power.

But, as he is possibly as ignorant of the inner details of cable construction and insulation requirements and the principles ruling them, as the cable maker's engineer is of the construction requirements of a polyphase dynamo, he has, in all probability, made a bad selection. That his and so many other plants using cables are successfully working to-day is possibly due to the fact that the cables are, from a "rule of thumb" design, made with an extra wide margin on the side of safety and might in all probability have been advantageously replaced by lighter and more economical cables.

That so many cables break down and so many supposedly inexplicable "blow outs" and "burn outs" occur in some circuits, is not so much a mystery as is the amount of voltage they have to restrain and that with an "insulation" that is doubtful throughout.

The unit usually employed to define the virtue of an "insulation" is that of the ordinary "conductivity resistance" test, the ohm, or rather a megohm. This seems, to say the least, unfit. It seems even wrong that a term and measure specially designed to determine the resistance of a conductor without reference to current at all, should be deemed also best for measuring the resistivity of a non-conductor with special reference to voltage and horse-power. A few words about the ohm may here be in place. There are several ohms, just as there are several wire gauges, and like them they all bear the approval of high authority. They all vary with temperature and none of them are alike at any temperature.

The first was the "unit" of Sir William Siemens, invented long before the unit of resistance was called an "ohm." It consisted of a glass tube containing a column of pure mercury one square millimetre in section and one metre long at 0 degrees C. This for a fundamental unit seemed to be as near perfection as common sense and practical knowledge could evolve for and from pure science.

The mercury was easily procured, the tube not difficult to make, and the whole thing portable enough. It could also be easily reproduced, either by measurement or weight, which is the second vital point in any standard. But it had two faults. It was called the "Siemens unit," and was universally adopted by all who used units at all.

So the British Association issued an "unit" called the B. A. unit, which was obtained by bending an indefinite length of wire of an indefinite weight into a circle of an indefinite diameter, and twirling it an indefinite number of times on its diametral axis, in an indefinite portion of the magnetic meridian, and so with infinite care and trouble obtaining an indefinite unit, which was urged on the use of the profession by all the powerful influence of the B. A., and who pronounced its value as something very close to the Siemens unit. Then the investigations of Lord Rayleigh upset this value. To settle the matter and get something definite for practical men to work with, the Paris Congress of 1884 declared the value of an ohm to be .06 metre longer than the Siemens unit. The British Association, however, settled the ohm as being .0482 metre longer than the Siemens, while the London (England) Board of Trade in 1892 finally fixed its value at .0627 more than the Siemens unit. As this cannot be commercially reproduced without reference to the original Siemens unit, it seems strange that so much trouble should have been taken to alter it.

Now the amount of resistance in the difference of length in any of the above is not great, and if all resistances were copied with exactitude from the same standard it would be well. But this is practically an impossibility, and resistance boxes vary much more than may be expected. Anyhow, there is sure to be an error in the original copy of the standard, if only a temperature variation, and

possibly, even very probably, a very small one; but multiply that by a million and then by the constant of the galvanometer, which may be anywhere from 10 to 600,000, and the error becomes one of noticeable magnitude. But it may be urged the error is a comparative or relative one and doesn't really influence the result. Not as between all cables measured by the same galvanometer, granted; but as between the same cable measured by different galvanometers and coils the difference may be sufficient to come within or exceed any result required by a specification.

But if there is an error in these galvanometer appliances for insulation tests why use them at all as actual measurers of cable values?

While the cable is in process of making, either in or out of water, the galvanometer is useful for detecting the least entrance of moisture to the core or the entrance of any body of a conducting nature into the dielectric, providing it reaches the core, but it will detect neither moisture nor foreign bodies which may enter the dielectric to within the hundredth of an inch of the core and yet fail to reach it.

So far galvanometer insulation-resistance tests are of use, even indispensable, but as a means of determining the value of any dielectric in terms of the voltage it will carry with a stated horse-power behind it, it is utterly valueless. And in a cable this is the value we want to get at.

The "insulation" of a conductor should be taken as meaning not alone the degree of perfection with which it is electrically separated from all other conducting matter, but also should be the measure of that restraint or power which compels the current to keep within the area of the conductor provided for it, under a pressure of a given number of volts and horse-power, and this cannot be measured, nor even approximately estimated, by means of an almost infinitesimal current acting on a proportionately delicate means of observation. The common sense of testing, if rightly applied, favors this conclusion. Using the term in its ordinarily accepted sense, insulation resistance is absolutely a matter of surface, while conductivity is as absolutely a matter of cross-sectional area.

Ceteris paribus then, a cable with half an inch of sectional area of conductor with one hundredth of an inch of thickness of insulation, would, according to galvanometer test, have a higher insulation than a cable with a square inch of conductor and a wall of insulation an inch thick. But no one would for a moment think that the one with the highest galvanometer insulation was the better insulated.

I am not desirous to add to the already formidable list of unit terms one has so much difficulty to keep pace with, but I think here is an opening for a well-considered term. I scarcely know myself how to define that property which, as distinguished from the moisture-excluding properties of an insulating medium, confines the current to the conductor in spite of its E. M. F. or pressure in all directions. Disruption has been used by one of our astutest electrical engineers to describe the act of a spark forcing its way through an insulator. "Spark resisting," "spark suppressing," "spark preventing" and even "spark repelling" have all been used to signify the same thing, but none of them can be considered correct. Literally, "insulation" would be good enough but, as already shown, it is in this application at least, unsatisfactory, and as will be shown further on, it is incorrect.

The term "insulation," may therefore be well confined in its application to those other branches of electrical science which have with good reason adopted it as fittest and best. But for all purposes in which high-tension currents are implied I would propose instead, the word "isolation." Etymologically both words have the same meaning, but the latter is more suggestive of the property or power possessed by the "isolator" or dielectric as affecting the voltage of a current in its relation to the conductor.

Thus dry air is certainly a good insulator, but only up to the point where it ceases to be an isolator, for it certainly ceases to be an insulator under a voltage exceeding its striking distance limit. The same remark applies to mica paper, oils, etc.

As a practical illustration let us consider the following example, coming under the writer's experience:

Take for instance a paper insulated cable without compound. Assume its length to be, say 1000 feet, and its "insulation" resistance by reflecting galvanometer to be 10,000 megohms, and that it will at that insulation withstand 20,000 volts alternating current snapped on or off or applied in any other way. Its isolation value therefore is 20,000, but has none at 21,000 volts, or to use the ordinary term its "insulation breaks down at 21,000 volts." Its "insulation," as a matter of fact, remains the same. Cut out the part affected by the 21,000-volt blow-out, connect the conductor ends again with a piece of wire and pile on the voltage until "isolation" is lost at say 26,000 volts. Its "insulation" remains the same. Continue this process until finally the cable's highest isolation point is reached of say 35,000 volts. The "insulation" still remains the same. Now strip the cable of its lead and compound it to saturation with say resin and thick resin oil. Its insulation will have fallen from 10,000 megohms to say 8000 at a similar temperature. But its "isolation" will have increased, and it will now be found perfectly safe when cold at 40,000 volts.

Now let us take a step further, put the cable in a tank, and turn on steam until the temperature of 212 degrees Fahr. is attained and keep it up for 24 hours or until there can be no doubt that sheath, paper, oil and conductor are all of the same temperature.

The "insulation" will have fallen from thousands of megohms, to thousands of ohms, but its "isolation" will be affected to but a comparatively slight degree and will only begin to fall again at about 20,000 or 25,000 volts. Experiments of this kind are costly and consequently few, but such as I have been enabled either to make or participate in, on lengths of over 1000 feet of cable with No. 6 or No. 8 conductor, have all resulted as above described.

Although this principle applies to other materials than resin and resin oil, this one example will suffice to show the distinction the writer would make between "insulation" and "isolation."

Mention has already been made to the remarkable isolation of a 350,000 mils cable with 9/32nds inch thickness of insulation made for the Niagara Construction Company, the specification calling for 25,000 volts isolation, while the company's officials actually proved its isolation as being good or active with an alternating current of 40,000 volts.

This was a "compound" rubber cable whose insulation certainly was lowered from what it would have been had pure gum only been used, but it seems to me certain that the successful isolation of its conductor under a pressure of 40,000 volts was due, in part at least, to the presence of some ingredient such as ground mica, whose isolating powers more than compensated for the loss of insulation resistance incurred by its use.

That dry air, however good an insulator it may be, is not the best of isolators, any one knows who has tried to pierce a block of glass with a spark from an inductorium, or witnessed the frantic attempts of a high-tension spark to complete its circuit by going round or over plates of glass, paraffin or mica, rather than through them, and this may explain why it is that compounded paper cable will carry a much higher voltage than one not compounded. It also leads one to conclude that the air spaces are the causes which facilitate the break down in a non-compounded paper cable, in spite of its insulation test being far higher than its equal, compounded.

The mechanical objections to resin and resin oil compounds have already been dealt with. Electrically, I conclude that at any temperature above that producing contraction into fissure, they are certainly the best isolators for high-tension currents yet known.

For cables, however, they have the disadvantage of a high specific inductive capacity, which, with the growing use of alternating currents, cannot be overlooked.

Under temperature changes the characteristic curve of loss of insulation as shown by galvanometer greatly resembles that of gutta percha, and remains steady in its deviation up to 300 degrees Fahr. or more, a characteristic which is absent from the curves shown by similar tests on a variety of other materials, which were undertaken by the writer a few years ago with a view to finding a substitute for this resin compound. The compounds experimented on were mixed by an expert and embraced a variety of materials, including both vegetable and mineral waxes and fats.

Up to the melting point, which ranged closely around 140 degrees Fahr., they all behaved somewhat similarly, showing a loss of insulation, according to galvanometer test, amounting to about one half for every increase of 10 degrees Fahr. Beyond the melting point resin oil compound showed a steady and proportionate approach towards a straight line, but the others became irregular and erratic up to 300 degrees Fahr. Ozokerite, however, beyond the melting point showed an exceptionally steady line of low value, due to its being used alone.

Subsequent experiments, carried on under somewhat adverse conditions as to regularity and sequence, but with every possible care to ensure uniformity and correctness, would occupy too much space to detail, but they may be generalized as confirming the statement that with all the E. M. F. at our disposal a spark which would pass through two or even three sheets of well dried paper, failed to pierce one of the same sheets when compounded, and apparently so long as

the paper was well compounded the nature of the ingredients used had no marked influence on the result, at least in these experiments. From what precedes therefore I think we are justifiably, if not inevitably, led to conclude that air spaces are bad isolators of high-tension currents and consequently weak points or faults in any cable designed to carry them, and that if such spaces, even of the smallest conceivable dimensions, are avoided, the cable, whether the dielectric be rubber, compounded fibre, gutta percha or secret compound with a commercial name, will be absolutely safe up to the natural sparking distance of the voltage across it, or in other words, up to the isolating limit of the material used, and that all indications of a reflecting galvanometer to the contrary may be neglected.

If then the galvanometer be abandoned, what shall be used in its place? I say use it in its place, which is in the manufacturer's testing room or the laboratory, not in the manholes or rooms of the cable users. If a cable is bad, it is bad, and is better condemned at once. It will last no longer if condemned by means of a galvanometer than if the fault so detected is blown out by a current. A galvanometer may condemn a cable still good, but a current cannot do so, and it is my belief that money and time may be saved by using a current of high E. M. F. rather than a galvanometer on a suspected cable. Certain it is that unexpected break-downs would be reduced to a minimum, if not altogether prevented.

Some four or five years ago one of the officers of a telegraph company told me that he spotted faults in telegraph cables without galvanometer, bridge or battery. The broken down cable was coiled up on shore and allowed to dry or not, as circumstances ordered. If repairs were to be effected when the cable had dried it was made wet and subjected to a difference of potential of 400 or 500 volts supplied from the company's dynamos on the other side of the river. "Where the fault is she smokes." Crude and heroic, but undoubtedly quick, effective and simple. I quote this as illustrating the principle of the method rather than the possibilities of its practice in underground cables.

In conclusion the writer, with all due diffidence, ventures to offer the opinion that with the increasing use of alternating currents and the growing tendency toward very high voltages, and especially considering the enormous possibilities of resonance effects, it would be to the advantage of cable users to pay more attention to securing cables with a low inductive capacity than with a high degree of "insulation" which is no isolation, and in a general way to work more towards considering cables as condensers rather than as insulated conductors.

Just as the gauge of a wire is what it measures in thousandths of an inch, no matter what the gauge may be called, so the isolation of a wire is the measure of the current it will carry, no matter what its insulation by galvanometer test may be, and in the writer's humble opinion evidence is not wanting to show that specifications for alternating high-potential cables should no longer call for "an insulation of so many megohms per mile," but for a perfect "isolation" of the conductor under actual test of so many volts, continued for so many hours, and supplied not by some arrangement about equivalent to a hand magneto, but by a well-defined amount of energy, whose source shall be of stated horse-power.

The expense to the manufacturer would not be very great, and even if it were, it is one which sooner or later will have to be met as unavoidable, for as the range of practical application extends, nothing can prevent that progressive change in its requirements, which "is born of the evolution of the inevitable."

New York and Haiti Cable Injunction Denied.

On Dec. 15 Judge Lacombe, of the United States Circuit Court, handed down his decision denying the motion of the United States for a preliminary injunction against La Compagnie Française des Cables Telégraphiques, the United States & Haiti Telegraph & Cable Company and the United States & Haiti Cable Company, to prevent them from laying and landing at Coney Island, without the consent of this Government, a submarine cable connecting this country with Haiti. In his decision Judge Lacombe says: "The laying of the cable was completed before this motion was submitted, and there is nothing to show that its operation, until final hearing in this suit, will produce irreparable injury to the United States or to any individual." A history of this case can be found in The Electrical World of Oct. 10, and a résumé of the arguments for and against the injunction asked for in the issue of Nov. 21.

The Relation of Magnetic Flux to Output in Dynamos.

BY P. M. HELDT.

In the design of dynamos there are several factors which are to a certain extent arbitrary. Text-books on dynamo design generally advise the reader to go over the construction of a machine similar to that to be designed, and to be guided by his observations. One of these more or less arbitrary factors is the useful magnetic flux. In what follows an attempt is made to deduce an algebraic relation between the useful magnetic flux and the output of a dynamo, and to evaluate the constant occurring in this equation from the data of actual machines.

As the fundamental equation of dynamo design we have $E = \frac{n\,C\,\Phi}{10^8}$ in which E represents the induced E. M. F., n the number of revolutions per second, C the number of conductors on the surface of the armature, and Φ the useful flux. Here C and Φ are generally unknown, and the equation can only be solved for one of these quantities after a numerical value has been assigned to the other. Theoretically it does not make any difference what value is assigned say to C, provided Φ is made such that the product $C\,\Phi$ has a certain value. But there are practical limitations to the number of conductors that may be employed. If the number is too small the machine becomes bulky, inefficient and expensive, while with too many conductors the machine will also be inefficient, and the magnetic reaction of the armature may become so strong that sparkless commutation of the current is impossible when running at normal load.

The output of a machine varies a little faster than its cubical dimensions. This is due to a higher peripheral velocity attained in large units and to a better utilization of the available winding space. We may say that the output varies as the $\frac{7}{8}$ power of the linear dimensions. The magnetic flux varies as the second power of the linear dimensions, and therefore as the $\frac{4}{7}$ power of the output. Accordingly,

$$\Phi = C\,W^{\frac{4}{7}}.$$

Testing this equation by applying it to the data of actual machines we find that C is not independent of the output, showing that in practice the above relation does not hold.

This result might have been predicted. Assuming two machines having a constant ratio n between all their linear dimensions, we have the following relations:

Magnetic reluctance varies as n^{-1}
Magnetic flux varies as n^{2}
Field ampere-turns vary as n
Angular speed varies as $n^{-\frac{1}{2}}$ to n^{-1}
Induced E. M. F. varies as $n^{\frac{3}{2}}$ to n
Armature current varies as n^{2} to $n^{\frac{5}{2}}$
Armature conductors constant
Armature ampere-turns vary as n^{2} to $n^{\frac{5}{2}}$.

We see thus that under such conditions the armature ampere-turns vary much faster than the field ampere-turns. The ratio of these two factors should remain constant as long as the proportions of the magnetic circuit remains the same, as is the case here.

The exponent $\frac{4}{7}$ has therefore no practical value. In order to find that value of the exponent which obtains in practice we write:

$$\Phi = C\,W^{x} \qquad (1)$$

as an empirical, algebraic relation between the magnetic flux and output of a machine. Let Φ_1, Φ_2, Φ_3 and W_1, W_2, W_3 represent the useful flux and output of different machines of the same general description, say surface-wound, constant-potential, two-pole machines with drum armatures. Then according to equation (1)

$$\Phi_1 = C\,W_1^{x},$$
$$\Phi_2 = C\,W_2^{x},$$
$$\Phi_3 = C\,W_3^{x}.$$

Dividing any two equations

$$\frac{\Phi_1}{\Phi_2} = \left(\frac{W_1}{W_2}\right)^{x}, \quad \frac{\Phi_2}{\Phi_3} = \left(\frac{W_2}{W_3}\right)^{x}, \quad \frac{\Phi_3}{\Phi_1} = \left(\frac{W_3}{W_1}\right)^{x}.$$

But as equation (1) is only empirical, the exponent x really has a different value for any two machines. In order to be correct, these last equations should be written:

$$\frac{\Phi_1}{\Phi_2} = \left(\frac{W_1}{W_2}\right)^{x-z_1}, \quad \frac{\Phi_2}{\Phi_3} = \left(\frac{W_2}{W_3}\right)^{x-z_2}, \quad \frac{\Phi_3}{\Phi_1} = \left(\frac{W_3}{W_1}\right)^{x-z_3}$$

where z_1, z_2 and z_3 are deviations from the most rational value of x either positive or negative.

Taking the logarithm of each side of the above equations, we have

$$\log\left(\frac{\Phi_1}{\Phi_2}\right) = x \log\left(\frac{W_1}{W_2}\right) - z_1 \log\left(\frac{W_1}{W_2}\right), \text{ etc.}$$

and similar values for $\log\left(\frac{\Phi_2}{\Phi_3}\right)$ and $\log\left(\frac{\Phi_3}{\Phi_1}\right)$

From this

$$z_1 = x - \frac{\log\left(\frac{\Phi_1}{\Phi_2}\right)}{\log\left(\frac{W_1}{W_2}\right)}$$

$$z_1^2 + z_2^2 + z_3^2 + \ldots = \left\{ x - \frac{\log\left(\frac{\Phi_1}{\Phi_2}\right)}{\log\left(\frac{W_1}{W_2}\right)} \right\}^2 + \left\{ x - \frac{\log\left(\frac{\Phi_2}{\Phi_3}\right)}{\log\left(\frac{W_2}{W_3}\right)} \right\}^2 + \ldots$$

According to the theory of least squares, the left-hand side of this last equation must be made a minimum, in order to obtain the most rational value of K. Equating the first differential coefficient of the right-hand side in the last equation to zero and solving for x_1 we find

$$x = \frac{\frac{\log\left(\frac{\Phi_1}{\Phi_2}\right)}{\log\left(\frac{W_1}{W_2}\right)} + \frac{\log\left(\frac{\Phi_2}{\Phi_3}\right)}{\log\left(\frac{W_2}{W_3}\right)} + \ldots}{n}$$

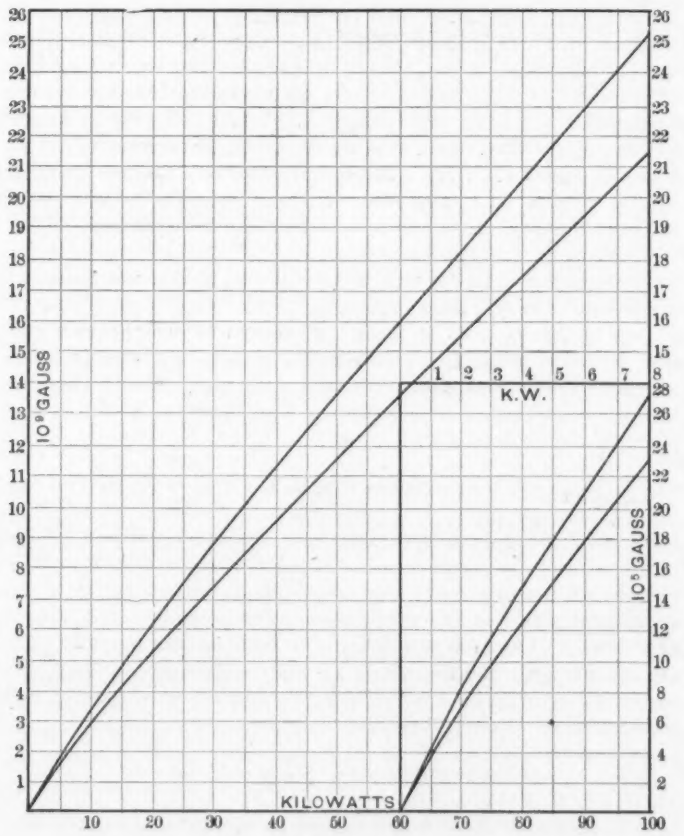


FIG. 1.

Proceeding in a similar manner to solve for C, we find

$$C = \frac{\frac{\Phi_1}{W_1 x} + \frac{\Phi_2}{W_2 x} + \frac{\Phi_3}{W_3 x} + \ldots}{n}.$$

The ratio $\frac{W_r}{W_{r+1}}$ should not be near unity, but should be nearly the same for all terms, in order to have the terms fairly accurate and of nearly equal weight.

Calculating x from the data of 18 surface-wound, constant-potential, two-pole drum machines of moderate peripheral speed, and ranging in output from ½ to 180 kilowatts, it was found to be 0.884. The values of C for the same machines lie between 800 and 1200, and the mean was 1023. The value of the constant given by the data of the machine determines to a certain extent its condition of operation. In a series of dynamos, designed on the same general principles, the writer found that the machine having the smallest constant required the greatest angle of lead when loaded. With dynamos of the above description and running at ordinary speeds, there need be no fear that an armature will have an over-large reaction when the constant is above 1000.

For ring machines the values of C do not agree nearly as well. This seems to be due to the widely different forms given to the rings. Rings with small magnet cross-section and large diameter always gave values of C below the mean, while the opposite is true of rings of more compact form. The mean value of C for nine surface-wound constant potential two-pole ring machines was found to be 862.

Generally speaking, ring machines have, therefore a smaller useful magnetic flux than drum machines of the same capacity. This fact may possibly account for the statement, sometimes found in text-books, that ring armatures have a greater reaction than drum armatures, which is not obvious otherwise. For slot-wound armatures one would expect the coefficient C to have a higher value than for surface-wound armatures.

For the sparkless commutation of the current from an armature having a certain number of back ampere-turns it is necessary that a certain M. M. F. be active in the air-gap. As the reluctance of the air-gap of slotted armatures is so small as compared with the reluctance of the air gaps of surface-wound machines, the flux in the former class of machines must therefore be relatively larger. Similarly one would expect a small constant for multipolar machines, as the magnetic reaction of an "n-pole" armature is only $\frac{2}{n}$ times the reaction of the same armature wound for a two-pole machine.

Both of the above observations are verified by the data of some slot-wound and multipolar dynamos which the writer has in possession, but they are not sufficiently large in number to draw from them conclusions in regard to the general practice in the design of these types.

The curves in the diagram represent the equations

$$\Phi = 1000\ W^{-.88}$$

and

$$\Phi = 850\ W^{-.88}.$$

The curves in the lower right hand corner are the beginning portions of the other two curves enlarged.

Award of Royal Society Medals.

At the anniversary meeting of the Royal Society, the president, Sir Joseph Lister, announced the award of the second Royal medal to Prof. Boys for his researches on measuring minute forces, by his invention of the mode of drawing quartz fibres, and by his discovery of their remarkable property of perfect elasticity. Prof. Boys used a combination of thermo-junction with a suspended coil in a galvanometer of the usual D'Arsonval type, a combination first devised by D'Arsonval himself, and by this means Prof. Boys developed the idea in the micro-radiometer, an instrument, according to Sir John Lister, rivaling the bolometer in the measurement of small amounts of radiation. In the case of the Rumford medal the Council made a new departure by awarding the medal in duplicate. As stated by President Lister, many physicists have studied the luminous and other effects which take place in a vacuum tube, but the extension of the field of inquiry to the external space around it is novel and most important. This extension has been due to two men—Prof. Lenard and Prof. Röntgen. Although differences of opinion exist as to the exact meaning and cause of the phenomena discovered by Lenard and Röntgen, few will dispute the theoretical interest with these discoveries embody.

The Davy medal was awarded to Prof. Henri Moissan for having accomplished the isolation of fluorine in a state of purity, and for his researches at extremely high temperatures by the aid of the electric furnace. President Lister stated that it is impossible to set bounds to the new field of research which has thus been opened out, and the electric furnace has now become the most powerful synthetical and analytical engine in the laboratory of the chemist.

Principles of Electrical Distribution.—II.

BY FRANCIS B. CROCKER.

TEMPERATURE COEFFICIENT OF COPPER.

The effect of variations in temperature upon the conductivity of copper was given by Matthiessen[1] in the following formula:

$$C = C_0 (1 - 0.0038701t + 0.000009009t^2),$$

in which C_t is the conductivity at any temperature t in Centigrade degrees and C_0 is the conductivity at zero degrees C. This expression is sometimes converted into one for resistance by merely changing signs, but this is incorrect algebraically since it is necessary to take the reciprocals of both members of the equation. If this is done the following formula is obtained:

$$R_t = R_0 (1 + 0.0038701t + 0.000005969t^2).$$

This is usually simplified by reducing the number of decimal places, giving the form:

$$R_t = R_0 (1 + 0.00387t + 0.00000597t^2).$$

It is doubtful, however, if this complicated formula is any more correct than the very simple expression:

$$R_t = R_0 (1 + 0.004t).$$

In fact Messrs. Kennelly and Fessenden[2] recommended the provisional adoption of this formula because it is much more convenient and probably more accurate than that of Matthiessen. These gentlemen give the results of the seven most important determinations of the coefficient, the mean being 0.004076. This is somewhat higher than the value recommended, but as the samples of copper tested were exceptionally pure in most cases, it is probable that 0.004 is more nearly correct for commercial copper since impurities tend to reduce the temperature coefficient. This last fact is strikingly shown in alloys, the temperature coefficient of some of which being less than one tenth that of pure metals. Matthiessen found nearly all pure metals to have substantially the same temperature coefficient as copper, the only important exceptions being iron and liquid mercury. The values given for these metals are somewhat variable, but are about 0.0045 for iron and about 0.0009 for liquid mercury.

The resistance of a copper conductor at a given temperature is calculated according to Matthiessen's results by the formula:

$$R_t = \frac{9.587\ (1 + 0.00387\ t + 0.00000597\ t^2)\ l}{d^2}.$$

which gives the same figures as those of the table of the American Institute of Electrical Engineers already cited. But if the simpler temperature coefficient is adopted, approximately correct values are obtained from the following expression:

$$R_t = \frac{9.6\ (1 + 0.004\ t)\ l}{d^2}.$$

This gives values agreeing with those of Matthiessen at about 40 degrees C., but somewhat greater values below that point, and somewhat smaller ones above it. For example, the resistance of a mil foot becomes 10.368 instead of 10.35 ohms at 20 degrees C., and 12.67 instead of 12.82 ohms at 80 degrees C. This, however, is sufficiently accurate for all ordinary calculations, the difference being less than that due to a variation in temperature of a fraction of one degree.

In fact, the variation in resistance of copper is so great with ordinary changes in temperature that it is rarely possible to predetermine it with great accuracy. The temperature of an overhead line may vary between — 20 degrees C. and + 40 degrees C. due to natural causes, which would alter the resistance about 24 per cent. A further increase of 40 degrees C. due to the heating effect of the current would make a total change of 100 degrees in temperature, and about 40 per cent. in resistance. Underground and interior conductors are not subject to such extreme variations in the temperature of their environment, but it often amounts to many degrees, particularly for the latter, and the heating effect of the current may be equally great. Fortunately, however, in electrical transmission or distribution the current does not ordinarily heat wires more than 5 or 10 degrees, the loss of voltage being usually the controlling factor. Under the head of current capacity the rise in temperature of the various kinds of conductors will be discussed later.

In any given case the probable temperature around a conductor and the rise due to the current can be at least approximately determined, so that resistance calculations can be made accordingly

It is customary to specify in plans and contracts that copper for electrical purposes shall have a conductivity not less than 98 per cent. of Matthiessen's standard. In some cases only 96 per cent. is required, but it should not be allowed to fall below this limit, as it is perfectly practicable to obtain copper of such quality, and inferior grades would not be enough cheaper to make up for their lower conductivity. Allowance should be made for this fact in calculating the resistance of conductors, the simplest way being to add 2 per cent. to the resistance as determined by means of a table or formula, if the copper has 98 per cent. conductivity.

The drop, or lost pressure in volts, is very easily and definitely determined from Ohm's law, by changing its ordinary form $I = \frac{E}{R}$ into $E = I R$. In fact this latter form is usually more convenient in electrical engineering than the ordinary one, since it can be written in one line and involves multiplication instead of division. The formula $E = I R$ is not only true of the whole circuit but also applies to any portion or branch of the circuit; and ordinarily it is far simpler and more likely to avoid errors if each part of the circuit is considered separately. In the case of a very complicated electrical system, with many lamps in parallel supplied by branching conductors, it would be practically out of the question to treat the circuit as a whole, but in any case, however complicated, it is always possible to divide the system of conductors into separate lengths, in each of which we can determine the current, the resistance, and therefore the fall of potential which takes place in it. In this case we may use the expression $e = i r$, in which e is the drop in volts, i the current in amperes, and r the resistance in ohms, each applying only to that particular part of the circuit. In most practical work the current i is given, since it is usually known how many lamps or how much power is to be supplied. It then becomes necessary to calculate the value of the resistance r, in order to have the proper value for the drop e, the latter being assumed or fixed by the conditions in each case. The product of i and r always has a definite value—that is to say, both factors can be expressed in exact figures. The common idea that a short conductor of very large diameter has no appreciable resistance is quite fallacious. For example, a bar of copper one foot long and one inch in diameter has one hundred-thousandth part of an ohm resistance. While this may be a negligible amount in most cases, it is always perfectly definite, and is often quite appreciable. Such a rod would carry one thousand amperes with a drop of one hundredth of a volt between its ends, or ten volts per thousand feet, which is by no means insignificant. Bars of this size or larger are often used in practice carrying correspondingly large currents, hence it is not safe to ignore resistance, even in the case of very large conductors.

Loss of Energy.—The second objectionable effect which resistance produces in electrical distribution is the loss of energy which it occasions. This loss is absolute, and must always occur whenever a current flows though a resistance. The exact value of this loss is given by the expressions:

$$\text{Watts lost} = I^2 R = E I = \frac{E^2}{R}$$

in which I is the current in amperes, R is the resistance in ohms, and E is the drop or lost pressure in volts, being applicable either to the whole circuit or to any part of it. From one or another of these expressions the loss of energy can always be ascertained, provided any two of the three fundamental quantities are known. These expressions give the loss which occurs continuously so long as the current flows; that is, it is the rate of dissipation of energy or the power wasted. For a given time t in seconds—

$$\text{Loss of energy} = I^2 Rt = E It = \frac{E^2 t}{R}.$$

If it is desired to convert this loss of energy into heat units, any of the above values may be multiplied by 0.24, since one watt-second is equal to 0.24 of a gram-degree.

This loss of energy, while quite considerable in almost every electrical system, usually amounting to from 5 to 25 per cent., is rarely the controlling consideration in electric lighting. The *drop*, which has already been considered, and the *heating limit*, which will be considered later, are usually of more consequence than the mere waste of a small fraction of the total energy. The success or failure of an electric lighting plant depends upon keeping the drop and heating of the conductors within certain limits, and the system is

[1] *Philosophical Transactions*, 1862.
[2] THE ELECTRICAL WORLD, Feb. 16, 1896.

practically worthless if these limits are exceeded; whereas, the loss of a slightly larger or smaller percentage of the energy does not greatly affect the economy of operation, being usually a very small item in the total expense.

But in many cases, particularly for long-distance transmission in contradistinction to local distribution, the relation between the first cost of the conductors and the energy lost in them is a matter of prime importance. This subject was first attacked in 1881 by Lord Kelvin, who read before the British Association a paper on "The Economy of Metal Conductors of Electricity," in which he attempted to give a general solution of the problem. The conclusion reached by him, and now known as "Kelvin's Law," may be stated in the following language: The most economical area of conductor is that for which the annual interest on capital outlay equals the annual cost of energy wasted. In other words, the total annual expenditure for interest on the investment and energy lost on the line is a minimum when these two items are equal to each other.

The importance of this law has usually been greatly overestimated, but gradually its limitations have been brought out. In 1886 Profs. Ayrton and Perry showed in papers before the Society of Telegraph Engineers and Electricians that Kelvin's Law applies only in certain cases, and they gave various modifications and extensions of the law. Prof. George Forbes has also contributed to this subject in his Cantor Lectures of 1885,[3] in which he showed that the portion of the investment which is not proportional to the cross-section of the conductor should be kept separate so that the amended law becomes: The most economical area of conductor is that for which the annual cost of energy wasted is equal to the annual interest of that portion of the capital outlay which is proportional to the area of weight of metal used. Prof. William A. Anthony, in an article on "Economy in Conductors, and the Limitations in the Applicability of Kelvin's Law,"[4] demonstrates the fact that in some cases Kelvin's Law gives absurd results, and may, for example, require that *all of the energy should be wasted in order to secure the highest economy*. This utterly unpractical condition is due to the fact that the minimum *expense* of operation is considered, and the energy *delivered* at the end of the line, which is still more important, is entirely ignored. In fact a great many laws of this kind can be deduced according to what factor or factors are considered. Abbott[5] gives 15 possible combinations of the six variable factors involved in the problem, but states that only 11 of these are likely to be of any practical importance. The six factors and the 11 cases are as follows:

V = the pressure at the receiving end of the feeder;
v = the pressure at the delivering end of the feeder;
W = the power given to the receiving end of the feeder;
w = the power obtained at the delivering end of the feeder;
I = the current in amperes, and
S = the cross-section of the feeder.

Case No.	Given.	Required.
1	V, v	I, W, w, S
2	V, I	v, W, w, S
3	V, w	v, I, W, S
4	V, S	v, I, W, w
5	v, I	V, W, w, S
6	v, W	V, I, w, S
7	v, S	V, I, W, w
8	I, S	V, v, W, w
9	W, w	V, v, I, S
10	W, S	V, v, I, w
11	w, S	V, v, I, W

This is a far more complete treatment of the case than that originally given, Kelvin's Law being only one (No. 5) of these 11 different cases. But any of these solutions of the problem is of somewhat doubtful practical value, and it is probably true that Kelvin's Law, or any modification or extension of it that has yet been brought out, has done far more harm than good in electrical engineering. It gives a false confidence in the results of calculations which may be totally at variance with real commercial economy. The reason for this difficulty lies chiefly in the fact that the actual costs of some of the items cannot be expressed, even approximately, as mathematical functions. Furthermore various incidental factors and particular conditions arise, such as the available sizes of machines, which render a general solution of this problem of little practical value.

In this connection it is a common mistake to forget that the interest and depreciation on the investment is a fixed and irretrievable expense, while the energy lost on the conductor depends upon the power transmitted. If the plant is lightly loaded, or is shut down entirely, owing to hard times, strikes, etc., the fixed charge is run on as usual, but the energy loss is greatly reduced, or stopped altogether. Hence it is not wise to lay the full amount of copper corresponding to the maximum or even the ordinary demands, as there is no control over the investment after it is once made, whereas the energy loss adjusts itself to the working conditions. This only applies, however, to the matter of economy and not to regulations of the pressure or the heating of the conductors.

It has already been stated that this question of economy in conductors is not usually the controlling one in electric light distribution, the drop and heating limits being more important. But it may become necessary in certain cases to determine the best size of conductor, as, for example, an electric light feeder. Probably the safest as well as the quickest method to arrive at a correct result would be to obtain, by means of one or more of the cases given above, a general solution of the problem; then this result should be carefully checked by assuming a larger and also a smaller wire, and estimating the economy that would be secured if they were substituted for the size of wire obtained by the calculation. The difficulties of calculating the various items of expense are greatly reduced by assuming a certain size of wire, and the various factors, which would be almost impossible to cover by a general formula, immediately become definite. Scientific and rational methods should always be preferred to empirical ones, but every experienced engineer will admit that when complicated questions of cost arise it is unwise to rely entirely upon general formulæ, which are almost necessarily abstract and incomplete. The attempt to force science beyond its legitimate limits has done great injury to many industrial enterprises as well as to science itself.

(To be continued.)

[3] London *Electrician*, Vols. XV. and XVI.
[4] *Electrical Engineer*, Oct. 31, 1894.
[5] *Electrical Transmission of Energy*, p. 457.

Boiler Efficency, Capacity, and Smokelessness with Low-Grade Fuels.*

BY WILLIAM H. BRYAN.

Probably the most interesting question now before the mechanical engineers of this country is the proper method of expressing the efficiency, or economy, of steam boilers, and with this is closely connected the entire subject of the methods of making evaporative trials.

Active discussion of the matter was precipitated at the Detroit meeting of the American Society of Mechanical Engineers in 1895, when a paper by Mr. F. W. Dean, of Boston, on "The Efficiency of Boilers, a Criticism of the Society's Standard Code of Reporting Boiler Trials," was read. Mr. Dean not only recommended a complete revision of this code, but took strong ground in favor of determining and reporting, in every boiler trial, the heat value of the fuel used and comparing that figure with the actual heat utilized in doing useful work in the boilers.

Broadly speaking, boiler efficiency means the ratio between the work done by the boiler and the fuel expended per unit of such work, or to put it more precisely, the ratio between the heat realized in useful work by the boiler and that existing in the coal which the owner has paid for.

Until recently the economic performance of a boiler has always been expressed in the number of pounds of water evaporated for each pound of fuel burned and for each pound combustible; the latter term meaning simply the remainder after deducting from the total coal burned the pounds of ash weighed back. There being wide variations between the temperatures of the feed water and the pressures carried at different trials, the above results were always reduced to the "equivalent evaporation from and at 212," which is what the boiler would have done had the temperature of the feed water been 212 degrees and the water evaporated at the same temperature or at atmospheric pressure. This enables comparisons to be made between different trials under different conditions of feed and pressures.

For some years past many engineers have believed that the efficiency thus stated did not tell the whole story. The "equivalent evaporation per pound of coal" is meaningless, unless we know all about the coal. The situation is not much improved by reducing it to the "pound combustible," as this latter term is easily liable to error, particularly with low-grade fuels running high in ash and making bad clinkers, such as are almost universally employed in this part of the country. These engineers strongly urged that in every boiler trial the coal burned be carefully sampled, and imme-

*Extract of a paper read before the Engineers' Club of St. Louis.

diately submitted to chemical analysis and calorific determination. The report of results should show these facts as well as the theoretical evaporative power or capacity of a pound of coal. Comparing this with the work actually done by a pound of the coal, the efficiency percentage is at once secured. In the opinion of many engineers, this figure is, everything considered, much the best method of expressing the economic performance of a boiler.

Much to our surprise, the agitation of this subject has developed remonstrances, and from quite unexpected sources. Some of the most noted engineers of this country, supposedly most familiar with boiler trials, have taken the position that the efficiency thus determined and stated would in no way improve the situation, and might, indeed, be misleading. These engineers do not seriously defend the "pound combustible"—in fact, they practically admit all that has been urged against it. Their sole ground of objection is the belief that the science of coal calorimetry has not yet reached such a point that implicit confidence can be placed in the results.

Eastern engineers, whose work is almost wholly with high-grade coals running very low in ash, have not experienced the trouble with the "pound combustible" that we have. Very few Western engineers share with them the lack of confidence in calorimeters. My own files contain more than 100 such determinations, made with all sorts of fuels, under all sorts of conditions, among them many different investigations of the same fuel at different times. The results show a consistency which cannot help inspiring confidence in the methods. Even if we admit that the coal calorimeters are not all they might be, the extended experiments which are now being made in this direction, and the resulting constant improvement in apparatus, must certainly bring about in the very near future—if they have not already done so—methods and apparatus which will meet every requirement.

While I am a hearty believer in the efficiency, as determined by the more modern methods, I believe, nevertheless, that the results per pound of coal and of combustible—both actual and equivalent—should be given in all reports, if for no other reasons than that everybody expects them, and that a report would hardly be considered complete without them. I am always very careful to state in addition, however, the efficiency in percentage realized of the calorific value of the fuel. It is then entirely a matter of choice as to which of these expressions the individual reader will give the most weight.

The performance of a boiler may be measured in many different ways:

A. By the capacity developed ordinarily and as a maximum.

B. By its fuel economy, under all the varying conditions of service,

C. By the dryness of the steam which it generates.

D. By the smokelessness of its performance, a condition which is of decided importance in large cities, and which depends as much on the particular setting or furnace employed as upon the boiler itself, if not more.

Evaporative trials are made to determine all the above features. They are also made to secure information on any of the following questions:

A. The value of the different fuels, to ascertain what grade of fuel will evaporate the most water for a dollar. In such trials all conditions must be kept as nearly constant as possible.

B. To determine the effect of different fuels, not only on the cost of doing the work, but also on the capacity, durability and smokelessness of the plant, and on the labor required to handle it.

C. To determine the relative efficiencies of different types of boilers, particularly of new and untried designs.

D. To secure the same information regarding the different furnaces, stokers or grates, all as applied to the same boiler; it being necessary to determine not only the difference of economy of the fuel, but also the effect of the changed conditions on the capacity, labor, smokelessness and durability of the plant.

E. To determine the effect of different conditions of operation, such as greater or less draft, mechanical draft, either forced or induced; different methods of firing; different conditions of the boiler as to cleanliness; different rates of evaporation, to determine the point at which the fuel economy is a maximum, and the extent to which the boiler can safely be crowded in emergencies.

Scientific and accurate determination of boiler performance has of late years received an impetus from the growing practice of paying for boilers on the basis of their economic performance. Every additional pound of water evaporated per pound of fuel burned, means a noteworthy saving in annual operating expenses, which saving can be reduced to dollars and capitalized, thus furnishing a measure of the increased investment which the purchaser can afford to make in the first cost of a boiler of more economical type. When this plan is followed, bids for boilers are asked for on some assumed basis of efficiency, frequently 65 per cent. to 70 per cent. After the boilers are ready for service, they are to be tested thoroughly by disinterested experts, and the contractor is paid a bonus on each boiler for every 1 per cent. which is realized over and above the stipulated basis. In case the results fail to reach the basis, then the contractor suffers a deduction for each 1 per cent., the amount being either the same as for the bonus, or greater.

When bidders make up their proposals in a case of this kind, they are supposed to know exactly what efficiency their boilers will develop under the conditions set forth in the specifications; or, if they do not know, they must ascertain. Having completed their estimate of the cost of the boiler and decided upon a figure which they must realize for the installation, they either add to or deduct from that figure a sum depending upon the efficiency which can be secured. Suppose, for instance, a builder desires to realize $3000 per boiler on a proposed installation, on which the efficiency demanded is 70 per cent., and a bonus of $250 is to be paid for each 1 per cent. above that point, and the same amount deducted if the basis is not reached. If the bidder is certain he can reach 75 per cent. he would be sure of a bonus of $1250 on each boiler, and could safely reduce his bid by that amount, offering the boilers for $1750 each.

The recent bidding for the new boilers of the Baden Pumping Station, of this city, is a prominent example of this method of procedure, the bids being about one-third lower than the same boilers could usually be purchased for in open market, the contractors nevertheless expecting in the end to realize the full selling price, or more. This method makes it to the contractor's interest to build a plant which represents the very highest improvements in economic performance, and should insure to the purchaser a plant which can be operated for the minimum expenditure for fuel.

The following table is an abstract of the results of a number of boiler trials made by the writer on the conditions and fuels common in this vicinity, nearly all of them being made on ordinary Illinois fuels. They represent the widest extremes of practice, including many badly designed and overworked boilers.

Kind of Boilers.	Number of Trials.	EFFICIENCY—PER CENT. Maximum.	Minimum.	Average
Small vertical	3	46.10	34.60	41.60
Large "	3	52.30	49.00	50.90
" improved setting	1	.....	One trial only	67.89
Tubular boilers	14	60.17	44.76	51.53
" improved setting	34	76.38	41.94	58.87
Water tubular	13	70.11	49.37	61.31
" improved setting	18	81.32	49.30	67.52
		SMOKE EMITTED—PER CENT.		
Common furnaces	7	75.42	11.09	46.52
Improved "	40	43.40	.29	9.45

The figures are quite interesting, indicating, among other things, that the best improved furnaces increase the efficiency over 25 per cent. above the best common setting under a tubular boiler, and about 15 per cent. under a water tubular boiler. The average daily results of the plants taken just as we find them, show that the improved furnace improves the efficiency of the tubular boiler about 15 per cent., and that of the water tubular about 10 per cent. The best water tubular boiler does over 15 per cent. better than the best tubular with ordinary setting, the increase, however, under average conditions being about 20 per cent. It is interesting to note that the *minimum* efficiency secured, both with tubular and water tube boilers, is lower with alleged improved settings than without them.

Scarcely less interesting are the results obtained regarding the prevention of smoke. The data from common furnaces represent them just as they were being operated in regular service. Those from the improved settings represent good, bad and indifferent devices. They show that the maximum smoke with improved devices is but little over half that from the common furnace, while the minimum is reduced to an imperceptible figure. As an average these figures indicate that improved furnaces have reduced the smoke fully 80 per cent. If we were to eliminate from this list all the notably poor devices, the average of the rest would show a reduction of from 90 to 95 per cent. Of 40 trials of improved, or so-

called "smokeless" furnaces, during which careful records were kept of the smoke,

3	average	less than	half of	1	per cent.
6	"	between	½ and	1	"
11	"	"	1	" 5	"
7	"	"	5	" 10	"
7	"	"	10	" 20	"
6	"	above		20	"

Hence it appears that smoke averaging less than 1 per cent. is not only possible, but is being secured regularly in everyday service in quite a number of large steam plants in this vicinity.

In designing a boiler plant to give the best results under all conditions of service, with low-grade fuels, the following desirable features should be kept in mind:

A. Ample draft; one inch of water or even more. Good results cannot be secured with drafts less than one half inch. Good draft and thick beds of fuel permit the high fire-box temperatures which we have found absolutely necessary.

B. Large ratio of heating to grate surface, so that while burning coal at a high rate per square foot of grate per hour, there is sufficient heating surface to reduce the temperature of the flue gases to 450 degrees Fahr. or less.

C. The combustion chamber should, if possible, be separate from the heating surfaces, so as to avoid their cooling effect. It should be quite deep—30 inches or more.

To secure the very highest results, the gases, after leaving the boiler-heating surfaces at not exceeding 500 degrees, should be passed through feed-water economizers and thence through air heaters. The feed-water, leaving the ordinary exhaust heater at a little above 200 degrees Fahr., may be raised to over 300 degrees in the economizer, and the heated gases reduced to 250 degrees or less. This reduction in temperature, of course, destroys the usefulness of these gases as draft producers, unless the chimney is very tall. The draft, however, can be better produced by exhaust fans, which draw the air through and out of the furnace and economizer, and discharge the gases at such a height above the roof that they will not be objectionable, thus doing away entirely with the necessity for high chimneys. Still better economy may be secured by placing air heaters in the smoke flue, beyond the fan, or between it and the economizer. Through these the air, entering the ash pit for purposes of combustion, may be drawn, so that the heated gases are finally discharged at a temperature but little above that of the atmosphere. The speed of the fan may be controlled by an automatic regulator, which increases the speed of the fan engine as the steam pressure drops, and reduces it as the pressure increases, thus performing all the functions of an automatic damper regulator. This plan is not experimental or untried, but has already been adopted in numerous large plants.

From the above it is evident that while the best modern water tubular plant, with improved setting, shows an efficiency 60 per cent. greater than the average efficiency of the common tubular boiler and setting found in this vicinity almost exclusively until a few years ago, there is still room for considerable saving. Whether all these refinements will pay in any given case can be determined only by consideration of all the conditions. With fuel as cheap as it is in St. Louis, there is, of course, a limit to the amount of money we should spend in improving a plant with a view of economizing fuel bills. As a general rule, however, it may be safely stated that the building of tall chimneys to secure draft, simply advertises the owner's lack of familiarity with modern improvements, or his want of confidence in results easily demonstrated. To this rule there are, of course, exceptions, as for instance, where the plant is small, fuel comparatively inexpensive and money not available, or where other considerations require that the gases be discharged at considerable elevation.

Retentive Fluorescence.

To the Editor of The Electrical World:

SIR:—Referring to the subject of phosphorescence of fluorescence screens, the following experiment affords a good illustration:

A Crookes tube giving an abundant supply of Röntgen rays of high penetrative power was excited by a powerful induction coil. A flat iron wrench was then placed against the screen of a fluoroscope and viewed in the usual way. On opening the switch in the primary the bright illumination of the screen ceased, but a very perceptible glow continued, making the dark shadow under the metal object plainly visible, although the tube was no longer excited.

After the primary circuit is broken the metal object may be removed from the screen, but its shadow will still appear surrounded by the glowing surface. If a completely darkened room is available for the experiment, the screen, after receiving the impression, may be handed around and viewed by different persons.

A number of different fluoroscopes were tested in this way for fluorescence, and all were found to possess the property to a greater or less degree.

MARTIN P. RICE.

SCHENECTADY, N. Y.

Compensating for Armature Reaction.

To the Editor of The Electrical World:

SIR:—In the issue of Nov. 14, 1896, of your valuable journal, Mr. F. H. Sleeper proposed a method of compensating for the injurious effects of the armature reaction on the magnetic field. Allow me to call your attention to the fact that this method is well-known, and was proposed by the writer in January, 1892, which will be seen by reference to my book on "Die Berechnung und Wirkungsweise Electrischer Glichstrom-machinen," second edition; also in the *Elektrotechnische Zeitschrift*, February, 1893, London *Electrician*, May, 1893, *La Lumière Electrique*, June, 1893. The book above referred to also contains, on pages 152 and 153, a description of a more ideal compensation method, which is identical with the one published by Prof. Ryan nine months later, and shown in the *Sibley Journal*, October, 1892.

J. FISCHER-HINNEN.

LE RAINCY, FRANCE.

Prof. Thomson and the Mouse.

If any reader of THE ELECTRICAL WORLD living near the residence of Prof. Elihu Thomson meets a mouse which appears to have been struck by lightning, he will confer a favor by returning it to the Professor. That mouse has a history.

Prof. Thomson, like many another scientist, has been experimenting with Röntgen rays, and knows perhaps more about them now than he did when he first began. Somebody said that continued applications of Röntgen rays would work injury. Prof. Thomson does not believe all he hears. He applied the Röntgen rays to his little finger for half an hour, and feeling no ill effects chuckled to himself that he had demonstrated their harmlessness. Nine days afterward, however, his finger became red and inflamed. The skin peeled off and the finger became so raw and sensitive that the Professor no longer doubted the injurious influence of Röntgen rays. That was six weeks ago and the finger still gives him trouble, although its condition is now improving.

Having one day caught a mouse, Prof. Thomson thought he would try the effect of the Röntgen rays upon the little rodent. After applying them for an hour he put the mouse into a small wooden box with a glass top, through which he was able to watch what changes might take place. The box was placed on a high shelf to await developments. One night the professor was writing and he heard a terrific clatter. Looking around he saw that his cat had undertaken to reach the mouse, and that cat, box and mouse had fallen to the floor in a heap. In the fall the box was broken and the mouse got away before either Prof. Thomson or the cat could prevent its escape. Thus ended what promised to be a most interesting investigation.

Discharges by Rontgen Rays.

It has been found by M. Jean Perrin that for the same gas at a constant temperature the quantity of electricity lost per unit mass of gas due to the action of Röntgen rays is independent of the pressure and proportional to the absolute temperature. According to the kinetic theory of gases the energy possessed by a molecule is also independent of the pressure but proportional to the absolute temperature. This analogy is worthy of careful consideration.

Telegraph Chart of the World.

The International Telegraph Bureau in Berne has recently published a very fine chart giving all the land and sea telegraph lines of the world used for through messages. It is correct up to July 1, and the various lines are indicated in different colors. It is furnished for the nominal sum of 6 cents.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

Non-Synchronous Motors and Wave Forms. ROESSLER. *Elek. Zeit.*, Dec. 3.—The conclusion of his long article (see *Digest*, last week). He discusses the primary current and the power loss in the iron; regarding the former he shows among other things that the primary current of the motor for sine curves can be less than with other curves, but the reverse is also possible; with curves which deviate with the sine form the magnetic leakage in the armature increases the primary current and the slippage, as also the secondary current, and therefore also the loss of power, more than with exact sine curves. Regarding the loss in the iron he shows, among other things, that all wave forms which differ from the sine form are more unfavorable than the sine form, in reference to the loss of power in the armature iron; the loss of power in both iron parts of the motor make it unadvisable to depart from the sine curve. In closing he gives a summary of his conclusions; referring first to what takes place in the motor, without regard to the magnetic hysteresis and leakage in the iron; the torque is greater with greater slippage, with sine forms the voltage curves, but with smaller slippages it is smaller than with other forms of curves; the maximum output of a motor is lessened by every departure from the sine form of curve; the heating in the armature is greater with all forms of curves which depart from the sine form than it is with the true sine curve; the primary current is largest for the sine curves when the armature circuit is open; with a short-circuited armature and revolving motor the relations become more favorable for the sine curves, the amount depending on the dimensions of the armature. Referring to the effect of the leakage, hysteresis and Foucault currents, the magnetic leakage diminishes the torque for two reasons, because with a given magnetic field the torque diminishes with the armature current and because the magnetic field itself for a given voltage becomes weaker; both effects are greater with more pointed curves; a departure from the sine form of voltage curve is therefore in general not to be advised, and the pointing of the curve is very unfavorable; the reduction of the torque with pointed curves involves an increased slippage and therefore an increasing armature heating, as also an increase of the primary current whereby the efficiency is also reduced; the effect of the form of the voltage curve on the loss of power in the iron through hysteresis and Foucault currents cannot readily be estimated for the revolving motor for the primary iron circuit; in the armature, however, every departure from the sine curve involves quite an appreciable increase in this loss. That which is more favorable for sine curves in the first portion of the conclusions is made still more favorable in the second portion; for motor work therefore one should endeavor to have the curves as nearly sine curves as possible; this agrees with the most favorable conditions of running for arc lamps, but is diametrically opposite to the requirements for the best conditions for transformers.

Direct Coupled Generator. Lond. *Elec.* and *Elec. Eng.*, Dec. 4.—A brief illustrated description of the new Siemens 500-kw dynamo recently installed in the Bradford station.

Speed Control of Electric Motors. ANTHONY. *Elec. Eng.*, Dec. 16; a suggestion of a new method.—The Leonard system is theoretically ideal, but requires a dynamo for each motor, and this dynamo sparks when the field is weak; regulating the speed of a motor by varying the field strength enables only comparatively small percentage variations to be obtained on account of the sparking. The control of the sparking depends largely on the density and stability of the magnetic fringe at the pole corners; this fringe disappears rapidly as the field is weakened; he therefore suggests having a two-path armature winding wherein the E. M. F. developed by the several pairs of poles are added together to make up the total voltage of the machine; one pair of poles could then be varied in strength without varying the others, the magnetic fringe at the corners of the unvaried poles would remain; a much greater variation of speed could be effected than would be possible if the whole field were weakened; an illustration, with a brief detailed description, is given; it is not necessary to magnetically insulate the magnetic poles which are to be varied, as a very heavy connecting yoke will serve to secure the necessary independence. In a six-pole machine the speed with one pair of poles cut out will be about 1.5, and with a pair of poles reversed about three times the speed when all are active, and between these all intermediate speeds are possible; the greater the number of poles the wider is the possible speed variation.

Care of Electrical Machinery. BAXTER. *Power*, December.—An article on the adjustment and care of brushes, giving practical hints, accompanied by some illustrations.

LIGHTS AND LIGHTING.

Train Lighting. Lond. *Elec. Eng.*, Dec. 4.—A brief illustrated description of the system used by the Southeastern Railway Company on the American type of cars. Each car has its own dynamo and accumulator, the former being driven from the axles; the novelty in the system is the means of getting a constant voltage independently of the speed of the train; the dynamo is suspended by a link so that its weight gives the necessary belt tension; the weight of the machine and the torque of the armature are said to exactly balance each other at normal output, while at greater outputs the belt slackens and slips over the pulley; the critical speed may be varied by a movement of the suspension link; the armature connections are reversed with a reversal of the direction of rotation. The system appears to be a success as 1500 sets are now in course of construction.

Cost of Electric Lighting. Lond. *Elec. Rev.*, Dec. 4.—A continuation of the article noticed in the *Digest*, Dec. 5; a few more replies are given, one of them being a detailed statement showing quite a large saving by the use of electricity.

Electric Arc for Lantern Projection. HOPKINS. *Elec. Eng.*, Dec. 17; the first of a series of articles.—After showing the advantages of the arc over other sources of light for this purpose, he discusses the elementary principles of the lenses showing the importance of having the source of light as small as possible, which requirement the arc fulfills better than any of the other sources; it also generates much less heat.

POWER AND HEAT.

Production of Ammonia and Nitrides by the Electric Furnace. MEHNER. Lond. *Elec. Rev.*, Dec. 4.—A note stating that a process is now being conducted in Germany, the essential features of which are that oxygen compounds of such elements as boron, silicon, magnesium, titanium and vanadium, capable of combining with nitrogen at a high temperature, are exposed to the heat of an electric furnace in the presence of free nitrogen and carbon; a high-tension current must be employed, unless the furnace be fed with coarse pieces of coke, and a jet of sand be blown in while generator gas is introduced; on entering the hot zone of the electric furnace the sand is said to evaporate and then acts as desired. Nitrides thus manufactured may be treated with steam to obtain ammonia and an oxide from which a nitride may be re-formed as before. No further information is given.

Preparation of Silicon in the Electric Furnace. MOISSAN. Lond. *Elec.*, Dec. 4; translated from the *Ann. Chimie et Physique*, November.—He showed that at a high temperature silica can be reduced by carbon; the silicon is always mixed with silicide of carbon; when the temperature is not too high a part of the silicon escapes the action of the carbon and is found in the bottom of the crucible; by cooling the silicon vapor as it is produced the process can be applied to the preparation of silicon.

Electromagnetic Elevator. SMITH system. *West. Elec.*, Dec. 19.—A long illustrated description of a system which is being tried experimentally in Chicago, in which the lifting power is produced directly by a core moving in the solenoid and a system of brushes which cut out sections of the coils and switch in those ahead of the plunger, thus producing a continuous pulling effort; the solenoid is enclosed in an iron casing. The arrangement as a motor cannot be compared in efficiency with the ordinary rotary types, but it is claimed that the greatly increased mechanical efficiency puts the whole equipment on a plane with the existing types of electric elevators in economy; the mechanical equipment is strikingly simple; it includes also a brake which keeps the car stationary during the stoppages, the brake being automatically released when the current is turned on.

Friction Power in Factories. BENJAMIN. *El'ty*, Dec. 16.—A reprint of the paper noticed in the *Digest*, last week.

TRACTION.

Douglas Southern Railway. Lond. *Elec.*, Dec. 4.—A well-illustrated description of this short line which skirts along the steep cliffs of the Isle of Man; the grades, profile, etc., are given; no portion of the track is level and scarcely any of it is straight.

Electric Traction Machinery. GIRAULT. *L'Eclairage Elec.*, Nov. 28.—A long, illustrated article describing the traction machinery which has been adopted by the Fives-Lille Company in France and is used in Angers, as also in other places; it differs in a number of respects from the

standard practice in this country; the article includes a test of the motor.

Railway Return Circuits. KNOX. *St. Ry. Rev.*, Dec. 15.—A reprint of a paper read before the Chicago Electrical Association. He discusses each of three methods of making the return circuits; the only perfect one is to have a complete copper return; the second and third methods are with bonds, with and without a supplementary wire; with bonds as they are at present he advocates not only return feed wires, but also supplementary wires, as there is not a bond which ensures beyond a doubt a perfect contact with the rail; he discusses this question of contact, showing some illustrations of existing cases which indicate how poor the contact was, especially if the bond has been in use for some time. Much of this trouble with the contact may, he thinks, be alleviated with a method which he is trying, and which consists in dipping the terminal of the bond in very hot melted solder, thus coating it with solder; then apply a metallic composition, known as a plastic alloy, to the walls of the hole in the rail, fasten the bond and cover the whole joint with a mixture of two thirds tar and one third pith pitch, packing sand ballast tightly around the joint. He does not approve of the riveting or "mauling" process in fastening bonds, on the ground that it destroys the springiness of the metal, which then cannot stand the jars and blows to which it is subjected; regarding the cast welded joint he expresses the belief that as it is now made it cannot be counted upon with any degree of certainty as having always the capacity of the rail. A smaller supplementary or return feeder than 500,000 circular mils he believes is unnecessary, as it will have too high a resistance compared with four bonded rails in parallel to do much good; he does not approve of return overhead feeders except in dark, alkaline soils. An illustration is given as a suggestion for return feeders in a complicated system; he approves of a potential wire used for testing and telephone services. In conclusion he gives a description of a few bonds.

Cast Welded Joint. BROWN. *St. Ry. Rev.*, Dec. 15.—An article giving the results of some tests, which show that although mechanically an excellent and perfect joint, yet electrically it is not to be relied upon. A joint made two years ago was broken open and it was found that the cast iron was not welded to the rail; after burying the joint for two months it was found that a film of iron oxid had formed and the resistance had doubled; some joints at Newark were tested after about an hour's use and it was found that the resistance of a foot of rail in each joint, which was also bonded with copper, was five times that of a foot of rail; some 50 joints were measured by him in St. Louis, and the averages are given; he concludes that cast-welded joints should be carefully bonded, and gives results of a test made, in which such a joint was supplemented with a plastic alloy joint made by drilling a small hole through the cast metal into the rail and filling it with the alloy, after which the drop in voltage on a foot of rail at the joint was practically the same as that in the rail itself.

Electricity for Steam Roads. Elec. Eng., Dec. 16.—A paragraph stating that the Cincinnati, Hamilton & Dayton steam road has become the owner of the street railway lines in Middleton, O., and will connect these with its main steam railroad tracks on which electricity will be used as the motive power; the service will be extended to Cincinnati.

Another paragraph states that electric traction will also be used in conjunction with steam in the new union station in Boston; the plans provide for the joint handling of electric and steam traffic; the suburban traffic south of Boston, which is very large, will be handled by electric trains.

Brighton Seashore Railway. St. Ry. Rev., Dec. 15.—An illustrated description of this road, which has frequently been referred to in these columns.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Comparative Cost of Gas and Electricity. STEVENSON. Lond. *Elec. Eng.*, Dec. 4.—A reprint of a recent paper in which he gives a comparison of the cost of supplying light by gas and by electricity in Manchester. The difficulty in such a comparison is to determine upon a common basis for the calculations; he limits himself to the question of the cost of supply, and does not consider the advantages or disadvantages on the consumer's premises; it appears that the electric light station and the gas plant are both under one management; the former has been singularly successful financially, yielding a working profit of over $55,000 last year; the conditions of consumption are very favorable, corresponding to about three times the average consumption of gas. He takes as a basis the equivalent in electrical units of 1000 cubic feet of gas of the illuminating power of the gas at Manchester; the gas yields 19.55 candles; for electricity he assumes an average of four watts per candle, and takes no account of the renewal of lamps; he thus obtains a quotient of 15.62 as the equivalent for lighting purposes in electrical units, of 1000 cubic feet of Manchester gas. He then gives in parallel columns the data for gas and electricity reduced to a basis of 1000 cubic feet of gas sold; from this the total cost of the gas, including interest and sinking fund, is 2s. 1.62d., that for electricity, 4s. 8.42d.; the revenue from electricity is almost three times as great, leaving a profit for gas of 0s. 2.61d., and for electricity 1s. 11.18d; he calls attention to the fact that the cost of producing electricity is much greater, but says nothing about the fact that the profits are greater; he claims that a gas plant to supply the equivalent in light of the electric station would cost only one fifth as much, which figure is questioned in the discussion; the cost of coal is less by one third in the case of electricity, showing that more light may be obtained by the indirect method, but he claims that this is only apparent, and that it is due to the imperfect and extravagant manner in which the energy of the gas is utilized, offering as proof the results obtained with the incandescent gas light burners; in the manufacturing cost, gas has a little advantage over electricity, but in the distribution there is a striking difference in favor of gas. The paper is followed by a long discussion, which, however, appears to contain nothing of special importance.

Combined Lighting and Traction Plants. RIDER. Lond. *Lightning*, Nov. 26.—An article intended to supplement the recent paper by that author and HESKETH (see *Digest*, July 4 and Aug. 8); he considers the various methods of utilizing present lighting plants for railway service. He divides the stations under three groups; in continuous-current stations in which the voltage is between 400 and 550, which will either be three or five wire systems, the generators might be used directly, but the objection is that one pole will be permanently earthed, which would interfere with the lighting service; the railway service cannot therefore be supplied directly from the generators while they are feeding the lighting network; a motor generator may be used, or the lighting and traction dynamos may be kept distinct; if they are of exactly the same type they may be used for either service, but then at least two engines must be kept going, each probably with a poor load factor; this may be obviated by the use of accumulators for each system; the best arrangement is to couple the engine and the two dynamos in line, with the engine outside, and a clutch coupling between it and the dynamos, the dynamos being permanently connected; the engine can then drive both or one for lighting and the other for traction, or both in parallel for lighting or for traction; with the engine uncoupled they may be run as a motor generator for either lighting or traction. In continuous-current stations generating under 400 or over 550 volts, motor generators can be used with advantage in conjunction with accumulators, in which case the current may be taken from the bus bars; two machines of 250 volts could be used in series as at Gera, but the plan is not to be recommended owing to the switching complications; a separate dynamo may be used to drive the motor generator, or the two machines may be coupled to one engine, as above described. For alternating-current stations it is necessary to use transforming apparatus in all cases; these transformers must lower the voltage and also change the alternating into a continuous current; this may be done by stationary transformers in conjunction with rotary ones or by means of motor transformers; the first method appears to have several disadvantages in practice, the machine is very liable to spark at the continuous-current commutator owing to the varying armature current, as the armature is acting first as a motor and then as a dynamo with each alteration of the current; the larger the size the more troublesome they become in this respect; Mengarini in Rome uses these and considers that 50 kilowatts is the maximum size which it is wise to use; the ratio of the transformation in the machine is also a fixed quantity and the regulation of the continuous-current voltage can only be accomplished by an adjustable transformer or resistance in the main circuits; the first cost of the two systems would probably differ little, but in ease of manipulation the motor transformer would be the better arrangement; this would consist of a synchronous alternating-current motor coupled directly to a continuous-current dynamo, any ratio of transformation may thereby be obtained, there is no more liability to sparking than in any good dynamo, and regulation becomes very easy; a double machine arrangement, with one engine, as above described, may also be used in this case. Mengarini in the installation in Rome has obtained excellent results with the railway plant, taking current from the ordinary alternating lighting mains; three diagrams are reproduced showing the load curve of the railways, the voltage record of the railway and of the lighting plant, which show how very satisfactory the accumulators and regulators perform their duty; the plant at Rome has been so successful that the number of cars is now being increased from 12 to 80; with accumulators some automatic means of regulation is necessary, either varying the number of cells in the circuit or providing a varying pressure across the terminals of the battery by a booster as it is done in America; the first method is used by Mengarini with considerable success, the cells being cut out automatically.

Railway Station Light and Power Plant. Elek. Zeit., Dec. 3.—A long well-illustrated description of a central station to supply light and power for the railway station and its approaches at Gleiwitz, from which power is also supplied for the machine shop and other machinery connected with the railway; it is of interest as being one of the first municipal electric plants in which all the power for the railway station is centralized and distributed electrically. The plant includes 172 arc lamps, 454 incandescents and 60 motors at a total of 160 horse-power; the three-wire continuous-current system is used with accumulators; when completed it will have a capacity of 1000 horse-power. The dynamos and engines are arranged so as to admit of raising the speed for charging a battery of accumulators; complete drawings of the connections and switchboard are included; the dynamos are connected to the outer mains, and the balancing current for the three-wire system is delivered by the accumulators; the charging is done with the aid of a booster dynamo driven by an

electric motor; the battery is always connected with the three wires, whether it is being charged or discharged.

Free Lamps. Lond. *Elec. Rev.*, Dec. 4.—A new scheme has been initiated by Gibbings at the Bradford station, which is in effect, that every consumer will be entitled to one 8 or 16 cp lamp free of charge, for every 60 kw-hours consumed during the past six months by the use of incandescent lamps only. Editorially it is thought that the station will recover the cost of those lamps in another direction; it has also been shown that although an incandescent lamp may after middle life consume more energy per candle, the total consumption is in most cases greatly diminished; a lamp which at first consumed 60 watts might drop down to 54 and a lower candle-power; experience shows that the consumers have very little appreciation of the gradual diminution in the light; it is therefore thought that by a greater consumption of energy per lamp the central station will cover its losses in providing free lamps; the consumer's bill will be slightly increased (by about as much as the cost of the lamps, according to the above argument), he will pay nothing for lamps and will always have a better light; it it thought that the scheme has much to recommend it.

Alternating-Current System. Bul. Soc. Int. des Elec., August-October.—A short note stating that the Schuckert Company has patented what they call a rigid system of distribution; the principal alternator is connected to the lighting and motor circuits, and a second alternator on the same shaft with it, but out of phase with it, is connected with one of its terminals to the middle of the armature circuit of the first and with the other terminal to a distribution wire for polyphase motors or for currents for starting the small alternating-current motors; it is similar to the monocyclic system and to the one used in Dresden.

Vevey-Montreux. Blondin. *L'Eclairage Elec.*, Nov. 28.—A brief description of this station which supplies current for lighting and for the railway, using partly power and partly steam.

Manchester. Lond. *Elec. Rev.*, Dec. 4.—A long well-illustrated description of this station with its new accumulator plant (see *Digest*, last week).

Comparative Value of Gas and Electricity. Oechehauser. *Eng. News*, Dec. 17.—An abstract of some figures recently presented at the German Union of Gas Manufacturers. For incandescent electric lighting 2 kw-hours correspond to 1 cb m of gas; with the arc light 1 kw-hour corresponds to 1 cb m of gas; for lighting 1 cb m of gas in Germany costs from 3.5 to 5 cents, while the cost of a kw-hour is 15 to 20 cents. For power purposes 1 effective hp-hour requires 600 to 800 liters of gas and therefore 1 cb m can be rated at 1.25 to 1.66 hp-hours; with electricity 1 kilowatt produces 1.08 to 1.22 hp-hours; thus a cubic meter of gas corresponds approximately to 1 kw-hour. For heating purposes 1 cb m of gas furnishes 2400 to 2600 effective calories in gas cooking apparatus, 3840 for heating water and 3628 to 4080 in general gas heating apparatus; 1 kilowatt will produce only 700 to 800 effective calories; gas for heating and power varies from 2.3 cents per cb m, while a kilowatt for the same purpose costs 5 to 7.5 cents.

Two Small Lighting Plants. Robbins. *Power*, December.—Illustrated descriptions, limited chiefly to the mechanical engineering features, of two small plants, one in a store in Columbus with a capacity of 3000 incandescents with some arc and motors, and the second one the No. 1 plant of the Block Lighting & Power Company located in New York City; it is contemplated to divide the city into zones of several blocks each and to place in each an electric lighting and refrigerating plant furnishing light, power, heat and refrigeration to the entire zone.

ELECTRO-PHYSICS AND MAGNETISM.

X-Rays and Penumbral Illusions. Sagnac. *L'Eclairage Elec.*, Nov. 28.—A short article calling attention to some luminous phenomena in order to point out the illusions which are often considered as refraction effects, and which are really effects of the penumbras. If the edge of an object is placed between a source of light of appreciable size and a screen, and if then the edge of a second object be moved between the source of light and the first object, but from the opposite side, the shadow of the first object will appear to be attracted to the shadow of the second, the effect being due to the penumbras; the shadow of a rod introduced obliquely into the penumbra of another object is bent as if due to refraction. The reproduction of a light photograph illustrating these points is given.

Residual Photo-electric Effect of Cathode Rays. Elster and Geitel. Lond. *Elec.*, Dec. 4; translated from *Wied. Ann.* 59, page 487.—They found that haloid salts of the alkaline metals, on exposure to cathode rays, acquired the property of being electrically discharged by light; this photo-electric sensitive state seems to be co-existent with the peculiar colorations of haloid compounds excited by cathode rays; they think that the rays exert a reducing action, the product forming a solid solution, like glass colored by gold.

Non-Deflectable Cathode Rays. Battelli and Garbasso. Lond. *Elec.*, Dec. 4; abstracted briefly from *Nuovo Cimento*, September.—Some time ago they found that some cathode rays were not deflected by a magnet; in the present paper they give their reasons for believing that this non-deflectable type of rays is not merely an X-ray. Editorially the thought is expressed that it appears that they have discovered the missing link between the Röntgen and Lenard rays.

Heterogeneity of Röntgen Rays. Roiti. Lond. *Elec. Eng.*, Dec. 4; abstracted briefly from the Italian.—He shows that there is a selective absorption when the ray are passed through metal foils, the selective property being similar to that produced by colored media on ordinary light. Relative transparencies of various metals will agree with themselves only when foils of the same kind of metal are used; if there is a combination of two or three metals the result is different from that obtained by taking the sum of the opacities of the separate sheets.

Discharging Electrified Bodies by X-Rays. Perrin. Lond. *Elec.*, Dec. 4; noticed briefly from *Comptes Rendus*, Nov. 23.—A note on the influence of pressure and temperature; as a result of his experiments he concludes that the quantity of electricity dissociated per unit mass of the gas is independent of its pressure and is proportional to its absolute temperature.

Discharge by X-Rays. Villari. Lond. *Elec.*, Dec. 4; abstracted briefly from *Nuovo Cimento*, September.—He arrives at some results with the discharge by X-rays, of conductors surrounded by various dielectrics; the discharge is increased by enlarging the surface impinged upon by the rays and also by enlarging the surfaces in the shadow.

Electrostatic Deflection of Cathode Rays. Jaumann. *Elek. Zeit.*, Dec. 3; abstracted from an Austrian journal.—He succeeded in deflecting cathode rays by electrostatic forces with an apparatus, the illustration of which is given in the abstract.

Experiments with Röntgen's Radiation. Trelfall and Pollock. *Phil. Mag.*, December.—A reprint with the illustrations of the complete paper which was abstracted in the *Digest*, Dec. 12.

Becquerel Rays. Becquerel. Lond. *Elec.*, Dec. 4; abstracted briefly from *Comptes Rendus*, Nov. 23.—An account of further investigations into the properties of the rays which he discovered were emitted from uranium and its salts and which he terms "uranic radiations"; he kept some of the salts in thick, sealed, leaden boxes for six or eight months, and finds by introducing a photographic plate that they continue to emit these rays almost as actively as when first placed in the box; he has not yet been able to find from where the necessary energy for these radiations comes; electrified bodies are discharged not only by the direct action of these rays but also by gases which have been submitted to their influence.

Incandescent Lead Wire. Skrginsky. *L'Eclairage Elec.*, Nov. 28.—A note describing a recent experiment before the Russian Physical Society. A current was passed through a lead wire 1 mm in diameter and 28 mm long, and was gradually increased up to 18 amperes when the wire was incandescent, without either melting off or falling to pieces.

Hall Phenomena in Liquids. Bagard. *L'Eclairage Elec.*, Nov. 28.—A reprint of an article from *Jour. de Physique*, 5, page 499.

Effect of Magnetization on the E. M. F. of Thermopiles with Iron. Lale and Fournier. *L'Eclairage Elec.*, Nov. 28; reprinted from *Comptes Rendus*, 123, page 801.—A note describing experiments; a thermoelectric couple made of a strip of copper fastened securely between the two armatures of an electromagnet was placed in circuit with a galvanometer and heated so as to give a fixed deflection; the magnets were then excited and it was found that there was a permanent displacement of the deflection, which displacement did not change direction when the exciting current was reversed; it acted to reduce the E. M. F. This experiment is in contradiction with the results obtained by Nichols and Franklin and confirms those obtained by Rowland and others.

Influence of Light on the Discharge of Electrified Bodies. Merritt. *Science*, Dec. 11 and 18.—A long article in which he gives an account of the investigations which have thus far been published concerning this subject, and beginning with the experiments of Hertz; it appears to be a very thorough summary. In his conclusions he states that it is clear from what precedes that a thoroughly satisfactory explanation of the discharging action of light has not yet been found, and that many questions concerning the phenomenon remain to be settled by a further experimental investigation. In a brief reference to X-rays he refers to some recent experimental results which were obtained, and adds that if these results are confirmed he thinks we shall be forced to the conclusion that the discharging of ultra-violet light differs essentially from the similar effect produced by Röntgen rays.

ELECTRO-CHEMISTRY AND BATTERIES.

The Electric Arc in Gases. Bone, Gerdan and Cain. *Proc. Lond. Chem. Soc.*; noticed briefly in the Lond. *Elec. Eng.*, Dec. 4.—They investigate the chemical combinations produced by the arc in various gases, the results being thought to be of interest in connection with the use of enclosed arcs. In pure dry hydrogen, methane, acetylene, as well as other saturated hydrocarbons, were produced, with small quantities of hydrocyanic acid; the arc will also decompose the hydrocarbons as well as form them; for the first 15 minutes they will be formed rapidly and after half an hour a state of equilibrium is attained, depending to some extent on the voltage.

Polarization of Thin Metallic Membranes. Grimaldi and Platania. Lond. *Elec.*, Dec. 4; noticed briefly from *Nuovo Cimento*, September.—They find that the E. M. F. is considerably larger in metallic films than in plates, especially when the current has just begun to flow; the rate of

polarization is correspondingly greater in the case of films; the condenser capacity of the plates is three or four times as high as that of the foil when the current has flowed for five seconds; they seek an explanation from the different quantity of ions which are occluded, which penetrate the thickness of the film in a comparatively short time.

New Accumulator. WARREN. *Chem. News*, 73, page 191; noticed briefly in the Lond. *Elec. Rev.*, Dec. 4.—He pastes the grids repeatedly with a composition of litharge and phosphoric and sulphuric acids, drying them for hours at 250 degrees F.; they are then piled up with alternate plates of amalgamated zinc and "insulating carbon blocks" in dilute sulphuric acid, to which 12 per cent. of phosphoric acid may be added; after reduction they are washed and peroxidized, being subsequently soaked in dilute phosphoric acid.

Electrolytic Precipitation of Gold from Cyanide Solutions. CROASDALE. *Eng. & Min. Jour.*, Dec. 12.—A short article giving the results of experiments with an improved process. The most difficult part of the usual process is the recovery of the gold from the solution; his experiments were made on a commercial scale and afford a basis for larger estimates; he used amalgamated zinc plates for the positive electrodes and sheet lead for the negative; the zinc was chosen for a number of reasons; it will precipitate gold without the aid from other sources; it is the most electro-positive metal available, and with the other electrode forms a galvanic couple which itself will precipitate the gold; by combining with this a weak electric current the zinc becomes especially active, and finally, the price does not make it impracticable. The strength of the current was 0.04 to 0.05 ampere per square foot of depositing surface; each square foot of surface received the gold from half a pound of solution in 30 seconds; the results of several tests are given showing an average extraction of over 98 per cent.; these results can be obtained day after day without difficulty. With lean solutions the flow was doubled and the extraction was 93.5 per cent. the zinc plates at the end of the experiments showed little or no wear and the surface kept bright; the destruction of cyanide was 2.8 per cent.; the solution which came from the tanks was remarkably active in dissolving gold, due to the presence of nascent oxygen, and the increased solvent action was fully as great as that produced by the addition of sodium peroxide or similar compounds. To show the advantages of zinc electrodes, he tried making both of lead and found that the current had to be increased five fold, and the plates had to be removed as soon as the current stopped, to prevent a re-solution of the gold, which does not take place when zinc electrodes are used; the solution coming from the tanks was inactive, although it became active after standing; a large amount of gas was formed; the recovery of the gold was 93.4 per cent. and the destruction of the cyanide only 5.15 per cent.

Accumulator Charging Switch. KIDWELL. *Elec. Eng.*, Dec. 16.—A illustrated description of some improvements in his switch for charging accumulators from arc-light circuits (see *Digest*, Nov. 21); some defects in the original apparatus are remedied and some improvements made.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Methods of Measurement at the Central Laboratory in Paris. JANET. *Bul. Soc. Int. des Elec.*, August-October.—A report from him as director of this laboratory, explaining briefly the standard instruments and measurements used at this laboratory. The measurements are based on the fundamental standards of resistance and of current; standard cells, it is thought, are not sufficiently reliable and constant, as compared with the other two standards; the standard instruments are described and illustrated; the resistance standard consists of 10 coils of one ohm each, so arranged that they can be connected into any desired groups; they are made of German silver wire of 1 mm in diameter, the coils being in a bath of petroleum. The standard for current measurements is the apparatus devised by Pellat in which there are two coils, one inside of the other, with the axes at right angles to each other, the outside one being horizontal and fixed, while the inside one has a vertical axis and is capable of moving around a horizontal axis; an absolute standard of this type is used besides several secondary standards which are calibrated by comparison with the standard. For obtaining a known difference of potential, a current measured by the current standard is passed through a standard resistance. A Kelvin balance is also used but is said to be less sensitive than the above-mentioned standard. For calibrating voltmeters they use a d'Arsonval galvanometer with a German silver coil and as a source of current there is a battery of 500 small accumulators, enabling them to measure up to 1000 volts; the cells are connected in convenient groups of 10 and are charged in sections, each one every 20 days. For calibrating alternating-current voltmeters, a Kelvin multi-cellular voltmeter is used, having first been calibrated by means of the accumulators; for alternating-current voltages a rotary transformer is used, the speed and excitation of which can be varied within wide limits for obtaining different frequencies and voltages; for very high-tension voltmeters up to 20,000 volts the absolute electrometer of Abraham and Lemoine is used.

Temperature Coefficient of the Hibbert Standard Cell. Lond. *Elec.*, Dec. 4.—A short article giving the results of measurements by Fisher, of cells which were tested since March; he measured them daily for several months. The results are remarkably encouraging, they agree closely with each other and show a very small temperature error, low internal resistance and quick recovery; cells may now be made of exactly one volt at any desired temperature; two curves are given for the rise of voltage with temperature; the rise amounts to 0.0000733 volt per degree centigrade, or practically less than 0.01 per cent. per degree; as far as potentiometer work is concerned, a rise of 10 degrees C. would not affect the accuracy of the reading 0.1 per cent., thus greatly reducing the number of check readings. As they may be made to give one volt at any set temperature, they can be constructed so as to give one volt in any given place, such as a cellar, cupboard, etc., the temperature of which is known.

Measurement of Temperature. CLARK. Lond. *Elec.*, Dec. 4.—The first portion of a short series of articles on the measurement of temperature based on the change of resistance. In the introduction he points out the importance of instruments which may be depended upon without recalibration by the user; with the present instrument, temperature has been advanced from one of the worst to one of the best measured physical quantities; he intends to give briefly the principles of resistance thermometry, outlining the elements of the subject with reference to principles rather than details. The present portion is on thermometry in general; it is somewhat elementary and seems to contain nothing new.

Photometric Quantities. VON HEFNER-ALTENECK. *Elek. Zeit.*, Dec. 3.—A reprint in full of a report on the recent International Electrical Congress at Geneva, with special reference to the conclusions regarding photometric quantities; the report deals almost entirely with the photometric quantities and includes a further discussion of the subject with an explanation of his reasons for having voted as he did as a member of the Congress; it is followed by a brief discussion and by the resolutions which were adopted by the Electrotechnical Society to which this report was made, to the effect that the conclusions of the Congress in regard to photometric units should be subjected to further proof and that they should be further considered by that society in conjunction with others, after a committee has reported on them.

Photometric Units. BLONDEL. *Bul. Soc. Int. des Elec.*, August-October.—A reprint which appears to be nearly if not quite in full of his Geneva Congress paper, which was noticed in the *Digest*, Sept. 5 and 26.

Graduation of a d'Arsonval Galvanometer. PELLAT. *Bul. Soc. Int. des Elec.*, November.—A short paper giving a parabolic formula of three terms of odd degrees, for calculating the graduations, including a table of observed and calculated values.

Method of Measuring the Temperature of Incandescent Lamp Filaments. JANAT. *Bul. Soc. Int. des Elec.*, November.—A reprint in full of the short paper noticed in the *Digest*, Dec. 12.

Current Standards. ARMAGNAT. *L'Eclairage Elec.*, Nov. 28.—An article describing the Pellat and the Kelvin standards for measuring currents.

Magnetic Units and Quantities. HOSPITALIER. *Bul. Soc. Int. des Elec.*, August-October.—A reprint apparently in full of his Geneva Congress paper which was noticed in the *Digest*, Sept. 5.

Error in Photometry. *Prog. Age*, Dec. 13.—A reprint of a short article from *The Gas World;* it is an investigation of the common statement that there is a radical error in all photometry methods arising from the fact that the source of light is not a true point; in the present mathematical investigation the source is assumed to be a flat circular disc 1.6 inches in diameter; the calculation itself is not given, but the results are put in the form of a table giving the correct results, those calculated by the law of the inverse squares, and the discrepancy between them in percentages; for a distance of 80 inches the discrepancy is assumed to be zero; the error increases, at seven inches it is 1 per cent., at two inches 10.6 per cent., after which it increases very rapidly. When two sources of light are compared with each other these errors tend to balance and the final error is only the difference between the two; the balancing will be more perfect if the intrinsic brightness of the two sources is the same and if the more distant source has a larger area than the nearer one; the errors would be exaggerated if a very brilliant small source at a distance is compared with a nearer less powerful source but of larger size.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Public Telephone Stations in Norway. *Elek. Zeit.*, Dec. 3.—An illustrated description of the transmitters in the public stations in Christiana, which require no attendant and will operate when the fee is inserted; it is the Jacobsen system and is quite simple. Telephony has made very extensive progress in the Scandinavian countries; in Christiana there is one telephone for every 35 inhabitants, in Stockholm one for every 18 and in the small town of Marieham, in Finland, there is one for every 13; in Christiana the charge in public stations is a trifle less than 3 cents, which though very small, is nevertheless much greater than the cost of the service, which latter, including the interest and reserve fund, was only about one quarter of the above charge, so that a charge of less than half the above amount would still yield a good profit; many of the large stations in Christiana are provided with the self-collecting arrangement mentioned above.

Machine Telegraphy. DELANEY. Lond. *Elec. Rev.*, Dec. 4.—A communication in reply to a recent unfavorable criticism of his system in that journal; the criticism claimed that the system was an ingenious combination of devices which have been tried or abandoned; he shows

that this would apply also to many of the successful applications of electricity and is therefore no argument against it. Since the original article was prepared important progress has been made in the direction of high speed; 8000 words per minute were transmitted through an artificial line of 250 ohms, 295 microfarads, with 115 volts; this corresponds to a speed of the perforated tape of 27 feet per second; such a high speed would be impracticable for regular work, but it shows the superiority of the transmitter and receiver; he has used the same tape over 100 times before it showed signs of wear; the moist receiving tape will remain in good condition for six weeks; he has obtained fairly good signals with tape four months old; an instantaneous start at 20 feet per second is possible; he estimates that with copper wires of about five ohms to the mile good signals can be obtained at from 1000 to 3000 words per minute, over distances from 100 to 500 miles and with wire of 850 pounds or about one ohm per mile, or 1000 words per minute over a circuit of 1000 miles.

Telephone Trunk Line System in Great Britain. Gavey. Lond. *Elec.*, and *Elec. Eng.*, Dec. 4 ; a reprint of the abstract of the discussion of his recent paper; the Lond. *Elec. Rev.* contains it more briefly.—In general the paper was greatly praised by the speakers but the discussion does not appear to contain much of special interest, consisting chiefly of questions, to which the author replied. Regarding the effect of railway currents on telephone circuits, he stated that if metallic loops are used under the conditions laid down in the paper, such circuits would be absolutely free from the external disturbances ; single wire lines cannot be protected. Swinton called attention to the great cost of holding a trunk line until the one who was called could be reached, and suggested that some arrangement should be made for a small charge for making appointments. Preece remarked, among other things, that the electrostatic capacity was very much increased in dry weather and in wet weather the electrolytic action produced a dulling effect on the current, with the result that there was no gain in speed by putting in leaks of that kind, but when they were inductive leaks an improved rate of working was obtained. Gavey, in reply to questions, stated that they had eliminated induction by means of crosses on parallel lines 30 to 40 miles long ; the system of twist wires was by far the best way of avoiding induction ; the minimum gauge of wire adopted by the department was 150 pounds per mile ; by using a smaller gauge the lines were exposed to serious danger from gales and snow storms.

Telephone Newspaper. Zeit. f. Elek., Dec. 1.—A reprint of the daily programme of this novel enterprise, descriptions of which were given in these columns several years ago; in this plant news is distributed continuously by telephone during the whole day, including some entertaining matter in the evenings, among which is always the overture at the opera house whenever there is a performance; it appears from the programme that stock quotations are given for 15 to 20 minutes about every hour or two; every few hours there is a review of the principal news items that have been transmitted before; the number of subscriptions has at present reached 6000, including a length of wire amounting to 330 miles; it is stated that it is now possible with the apparatus in use to transmit simultaneously to 20,000 subscribers with sufficient loudness.

Disturbances in Telephone Lines Due to Neighboring Currents. Wietlisbach. *Bul. Soc. Int. des Elec.*, August, October.—A reprint, apparently in full, of his Geneva Congress paper, which was noticed in the *Digest*, Sept. 5 and 26.

MISCELLANEOUS.

Prizes. Bul. Soc. Int. des Elec., November.—A list of the prizes and conditions offered by the Industrial Society of Mulhause for 1897, all of which are for electrical subjects.

Geneva Congress. Bul. Soc. Int. des Elec., August, October.—A long reprint of a number of the papers read at this recent congress, all of which have already been noticed in these columns.

Lightning in California. McAdie. *Jour. of El'ty*, September.—A tabulated record showing the distribution of thunder storms in California where they occur throughout the whole year, although the damage done is not nearly as great as that done by lightning east of the mountains. It is followed by a short article referring to some interesting experiments on atmospheric electricity made by the United States Weather Bureau with kites of the Hargrave pattern, which are flown by means of fine steel piano wire from the roof of a high building ; the general points brought out were that there was an increase in the potential with the elevation, that the potentials were generally high, sometimes thousands of volts, that sparks could be obtained from a perfectly cloudless sky, even at an elevation not exceeding 500 metres, and, finally, that during the thunder storms the phenomena are usually pronounced.

Electricians' Slide Rule. Low. *Jour. of El'ty*, September.—The beginning of an article on the Smith manifold calculator, which is merely a slide rule with the characteristics pertaining to the areas of the various sizes of wire in the B. & S. gauge, and with some functions of an electric circuit as based on Ohm's law; the numerous calculations that can be made with it are enumerated, and each will be described.

Electricity in Naval Life. Fiske. *Elec. Eng.*, Dec. 16; a continuation of his long reprint.—He describes briefly, without illustrations, the position finders for both measuring and signaling, the principles being similar to those of the range finder.

New Books.

X-Rays. By Edward Trevert. Bubier Publishing Company, Lynn, Mass. 78 pages; 42 illustrations. Price, 25 cents.

This little treatise is written in a popular manner and it consists chiefly of matter collected from the various technical papers and the daily press. After giving a short biographical sketch of Prof. Röntgen, in the first chapter are considered the principles of the induction coil, its construction and use. The various forms of vacuum tubes employed up to the time of the writing of this book are described and illustrated. The radiographs are, as a rule, very crude, being among the first taken in this country. The fluoroscope is described at some length, and various fluorescent substances. The book, as a whole, is of little value to those who have followed up the subject of Röntgen rays in the technical press.

"Electricity in Paterson."—William M. Brock, general manager of the Edison Electric Illuminating Company, Paterson, N. J., is the author of a neat book intended for distribution among the patrons and friends of the company. The title of the work is "Electricity in Paterson," and its purpose is, according to its own announcement, "to present to the business man and everyday reader in simple language a comprehensive exposition of electrical matters." It treats of the practical application of electric currents, and by means of elementary illustrations these applications are very clearly represented. The book will serve a useful purpose, and will no doubt be instrumental in dispelling from the minds of many of its readers the unwarrantable mystery that yet clings to the electrical business. The book is neatly bound and well illustrated.

The X-Ray or the Photography of the Invisible and Its Value in Surgery. By William J. Morton, M. D. Written in collaboration with Edwin W. Hammer. American Technical Book Company, New York. About 231 pages, 91 illustrations. Price, 50 cents.

Judging from the number of books on Röntgen rays which have lately made their appearance, one is led to believe that the subject is not losing interest and that the popular demand for such literature is on the increase. The authors of this book have made a fairly creditable attempt to supply a small share of this information. The first part of the book is devoted to an exposition of the electrical units and the elements of electricity. The principles of the induction coil, the conservation of energy, thermal electricity, batteries, dynamos, methods of using coils, various forms of vacuum tubes, the construction and use of the fluoroscope, photographic apparatus, etc., are described. The authors then pass on to a consideration of the cathode and Röntgen rays, the source of the latter and their dependence upon the state of the vacuum, etc. The fourth part of the book is devoted to setting forth the surgical values of Röntgen rays and their use in dentistry. This is followed up by giving a number of radiographs, most of which are excellent. The book is written in a clear manner and is suitable for any intelligent reader desiring to obtain a knowledge of the principal features of Röntgen rays and the methods of producing them.

The Chicago Main Drainage Channel. By Charles Shattuck Hill, C. E. The Engineering News Company, New York. 129 pages. Price, $1.50.

This work is partly a reprint of a series of articles published from time to time in the *Engineering News*, and partly new matter. It starts with a history of the inauguration of the project, and then proceeds to give a full and accurate account of the whole enterprise as nearly as possible up to date, ending up with an appendix on the effect of the drainage canal on the level of the great lakes. This latter effect it is estimated will amount to from 0.2 to 0.4 of a foot in the level of Lake Michigan if the full amount of 10,000 cubic feet of water per second be allowed to follow through the canal. The area of Lake Michigan being 22,400 square miles, it would take about 60 days of 24 hours to remove one inch in depth of water if it were drawn off at the rate of 10,000 cubic feet per second, and not replenished at all, so that the estimated reduction of level looks large. If, however, the fact be noted that 10,000 cubic feet per second is about 4 per cent. of the normal discharge of water through the St. Clair River, which is the combined outflow of Lake Superior, Huron and Michigan, or about 15 per cent. of the outflow of Lake Michigan alone, the estimated change of level looks very moderate. The subject is treated in a thorough manner, and the book is to be recommended to all who are interested in hydraulic engineering.

Street Railway Investments. A Study in Values. By Edward E. Higgins. Street Railway Publishing Company, New York. 1895. 102 pages. Price $2.00.

The object of this work is to call attention to the relative values of street railway properties operated respectively by horse, cable and electricity, and based upon data obtained during the past three years. The author has from this attempted to predict the limits of the gross and net earning power of any road under different conditions of traffic. He points out that the securities of the present day are greatly over-valued, due to the purchase of old lines at high prices, the expense of reconstruction, reorganization and the development of new properties. This is particularly so in lines operated in small cities of about 20,000 people or less. The more perfect motive power has increased the profits enormously, which facts, however, lead to over-capitalization, a result especially prominent in electric railways, and one likely to render such roads

unable to pay interest on their mortgage indebtedness in cities up to 25,000 population. The author has based his estimates on the operating expenses as compared with the percentage of passenger income. A data sheet supplements the work and gives statistics pertaining to 145 roads, 13 of which are suburban. The facts contained in this table show respectively the statistics of capitalization and operation. The former includes the miles of track, capital stock, funded debt, capital liabilities, floating debt, each calculated for the total amount, per mile of track and per capita, while the statistics of operation include the population, car mileage, passenger income, operating expenses and net earnings. This work sets forth the underlying conditions which determine the successful operation of a road, and when the same is likely to prove a successful venture. The book will be found of value to those contemplating investment in street railway enterprises.

Excelsior "97" Arc Lamp.

The Excelsior Electric Company, of New York, has brought out a new type of enclosed arc lamp, for constant current, constant potential or alternating current, which possesses several features of interest and novelty.

The lamp is 35 inches high over all, and of graceful and pleasing design. It burns but one set of carbons in 15 hours' service, the top carbon being 5/8 inch diameter by 14 inches long; the bottom 1/2 inch diameter by 12 inch long, and it is claimed that the pressure to maintain the candle power will not vary more than one volt.

The mechanism of the lamp is in many respects novel. At the top of the frame is a sprocket wheel whose shaft, carried on a tilting bearing, can be lifted by a magnet spool in series with the arc. Over the sprocket wheel runs a chain, one end of which is attached to each carbon. Running against the sprocket wheel, and loose on the same shaft, is a worm wheel, a ratchet clutch being cut on the adjacent faces of the sprocket and worm wheels. When the tilting frame carrying these wheels is lifted by the magnet, a spring forces the sprocket and worm wheels together, locks the ratchet clutch, and the sprocket wheel revolving a few degrees opens the arc.

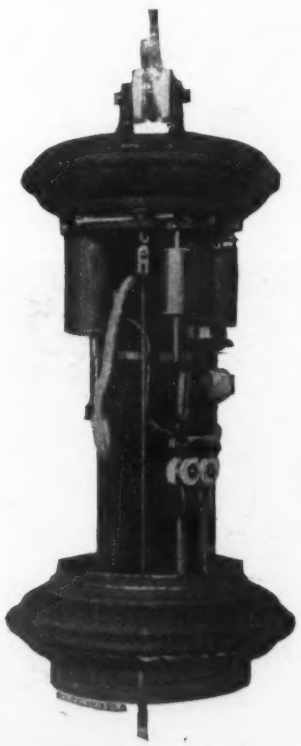
The vertical worm, which engages with the worm gear, is driven by a ratchet mechanism worked by the shunt. The armature of this coil carries an interrupter similar to that on a vibrating bell. When the increasing resistance of the arc causes sufficient current to flow through the shunt the armature is pulled against a spring until the shunt circuit is broken at the interrupter, when the vibrating action sets in, turning the worm and very slowly revolving the gear and sprocket, thus shortening the arc. In practice this proves to be a most sensitive and delicate regulation, an addition of one volt to the normal potential difference across the arc being sufficient to set the shunt vibrator in operation.

In other enclosed lamps the heat of the arc soon reaches the working parts, causing the resistance of the shunt coil to rise, and hence lengthening the arc and causing a circuit of such lamps to constantly increase in resistance. This difficulty has been largely overcome in this lamp by the use of German silver wire on the shunt coil, the resistance of this wire increasing very little with temperature. In order to prevent sparks at the vibrating break the coil is wound with a resistance of nearly 1700 ohms.

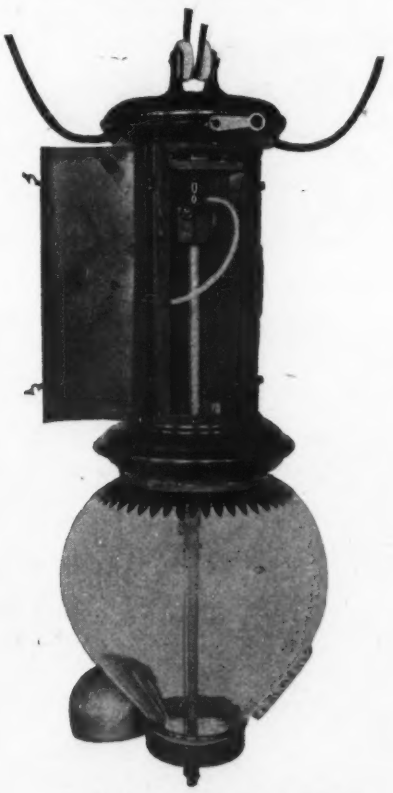
When arranged for constant-current circuits these lamps are provided with the usual automatic cut-outs and switches for short-circuiting. Arranged for constant potential, the cut-out is omitted and a resistance of German silver wire wound in the upper case is provided.

The difficulty of properly cleaning and trimming many of the enclosed arc lamps now on the market led Mr. William Hochhausen, the designer of this latest addition to the products of this company, to pay particular attention to this feature in his new lamp. In position for trimming, both carbon sockets are easily accessible without removing the globe and permit the insertion of the carbons quickly and without disarrangement of the lamp mechanism. At the bottom of the globe is the ash pan, which is held in position by a spring. To trim the lamp this is thrown back out of the way, where it remains automatically, and the door in the upper part of the casing is opened, exposing the upper carbon socket. The mechanism, however, is not exposed to the weather by opening this door.

EXCELSIOR "97" ARC LAMP.



LAMP MECHANISM.



LAMP COMPLETE, CASE OPEN.

An Interesting Three-Phase Plant.

An interesting though small three-phase power transmission plant has been installed at Itasca, Wis., where the shops, round-houses, and storerooms of the Chicago, St. Paul, Minneapolis & Omaha Railroad Co. are located. In their operation the company utilizes power for an average of 12 hours per day and steam the entire 24. About a mile and a quarter away from Itasca extensive docks have recently been built and on them has been constructed a warehouse 1500 feet long and 300 feet wide. Boats are loaded and unloaded on one side of the dock, tracks are laid the entire length of the opposite side and the cars load and unload their freight at any point in the warehouse.

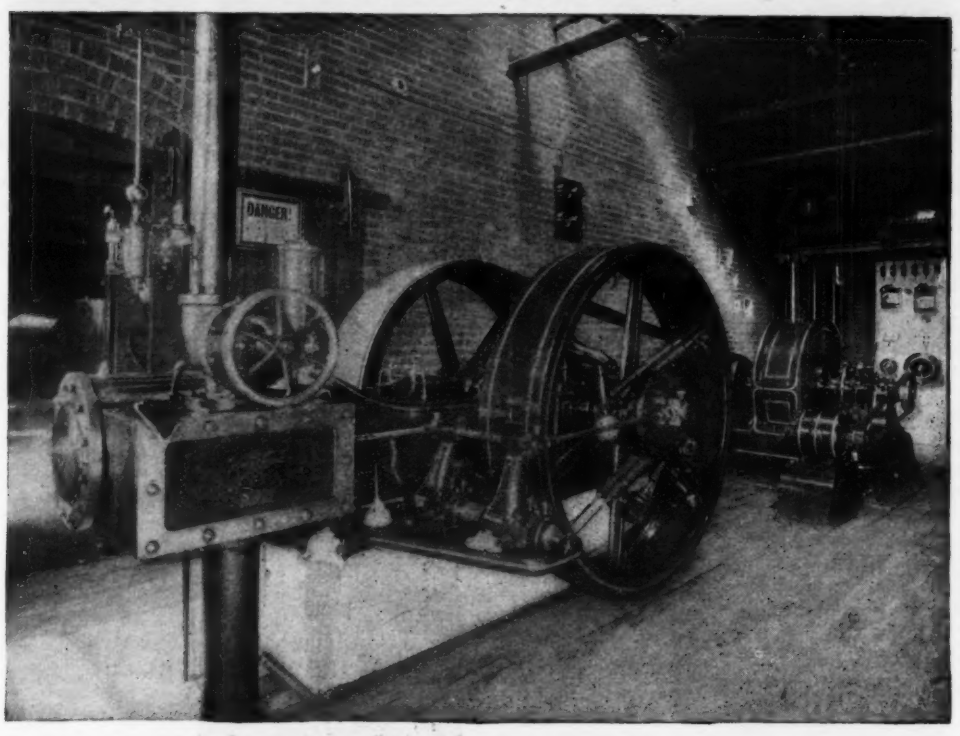


FIG. 1.—GENERATING PLANT AT ITASCA.

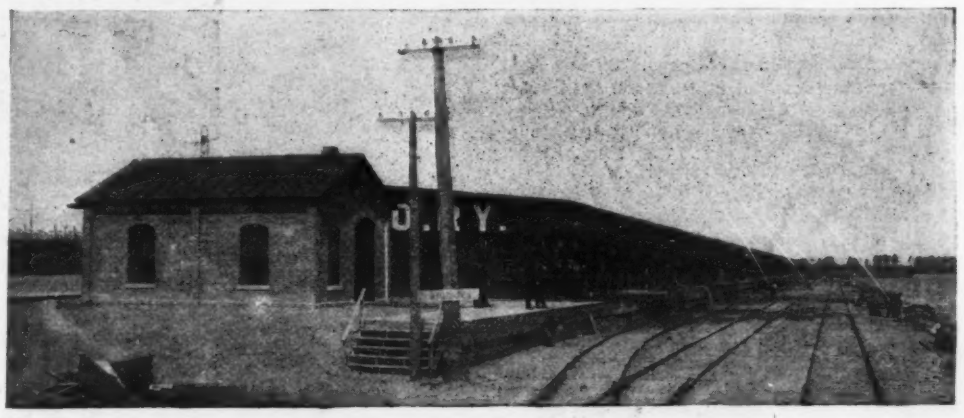


FIG. 2.—WAREHOUSE AND DOCK.

The protection of the warehouse from fire, containing as it does many thousand dollars' worth of property, was one of the first considerations after the construction of the building and naturally the first idea was the purchase of a steam plant and pump. About this time the attention of the railway company was called to the numerous power transmission plants which the General Electric Company had installed, and it was not loth to take advantage of the merits of the three-phase system of transmission. The result is that at the present moment a 750 gallon pump is operating, and incandescent and arc lamps are scattered over the warehouse and dock, the shops, roundhouse and other buildings at Itasca, all operated by current from the power plant.

The electric current is generated from a General Electric 100-kw three-phase generator, at a voltage of 2000 volts, this voltage having been adopted in order to do away with the necessity of step-up transformers. The generator is driven at a speed of 900 revolutions per minute by a Ball & Wood engine of 110 horse-power. At the dock the pumping plant is installed. This consists of a 75-hp General Electric 200-volt induction motor coupled to a Gould double-acting pump having an output of 750 gallons per minute, operating at 80 pounds pressure and competent to throw four effective fire streams upon the docks and into the warehouse.

The dock warehouse is provided with five fire stations, fitted with electric fire-alarm apparatus for transmitting signals between the docks and the engine house; also switches connecting the motor and the pump to the power wires. Hydrants and reels are suspended from the walls, each reel having 100 feet of hose, so that after the fire signal has been given from the engine house, one man can carry hose and water to the fire in from 10 to 30 seconds. A fire corps has been organized and the men are drilled three times each week.

The railway company by this installation is enabled to save the expense of an engine and pumping plant at the dock, besides effecting considerable economy in the operating expenses. In addition to current furnished the pump the generator also supplies electricity to 12 alternating-current arc lamps on the dock. Over 200 16-cp lamps are required to light the warehouse, and in Itasca itself about 150 more 16-cp incandescent lamps are also installed. The insurance companies have, it is stated, expressed satisfaction at the adoption of electricity.

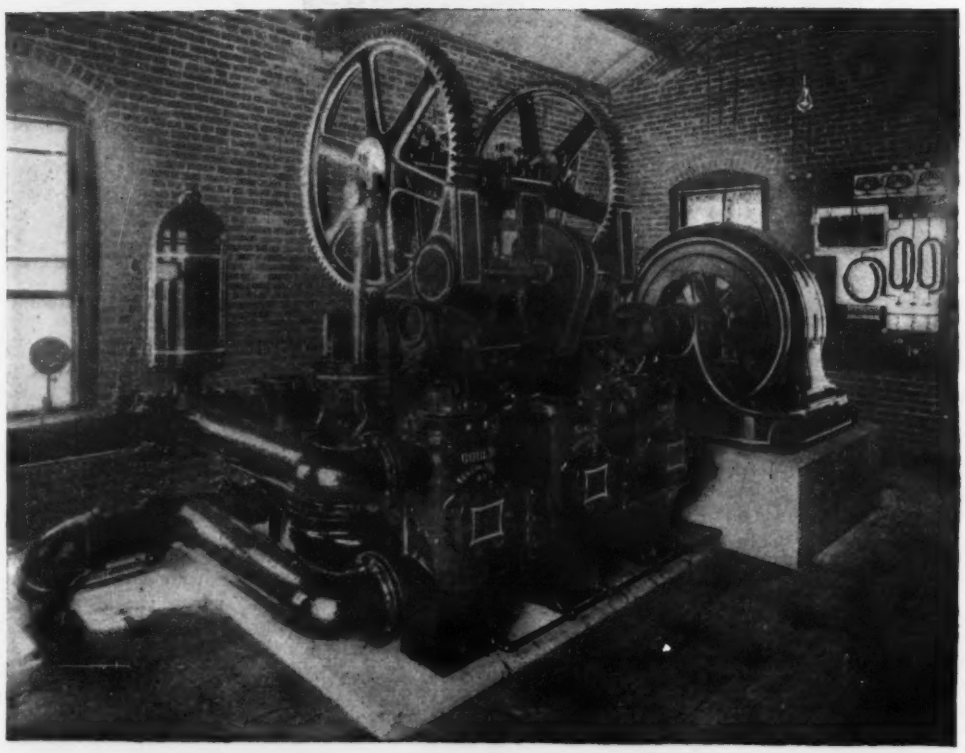


FIG. 3.—PUMPING PLANT AT WAREHOUSE.

An Auto-Car Battery.

In THE ELECTRICAL WORLD of Dec. 5, page 705, was published an article under the above title, in which were given two tables of laboratory tests of the Faure-King type of cell. Through an error the main column headings were not properly spaced. In both tables the words "Charge" and "Discharge" were made to apply to five columns each. The word "Charge," in both cases, should have applied only to the second column, headed "Rate Amps," and the word "Discharge" should have covered the remaining columns, which numbered nine in all.

Natural Waters and Their Effects in Steam Boilers.

BY GEORGE W. LORD.

It is well known to all competent observers that the usual system of boiler management as practiced in the average power and lighting plant to-day is accompanied with a great waste of fuel and much wear and tear as regards its boiler equipment. Further, that comparatively little attention has been paid to this matter either from habitual indifference to its occurrence or from want of information as to causes. Even in the best organized and conducted plants this condition is known to generally prevail, and it is difficult to assign any intelligent reason why this is so, yet it is manifest that any neglect or abuse of the steam-boiler equipment must directly and greatly affect the economical management of any power plant, its prosperity and dividend-paying power. The prodigious amount of study, labor and profound thought devoted by mechanical experts to the perfection of modern types of boilers should stimulate and encourage boiler owners to treat these beneficent inventions with the most painstaking and conscientious management, so as to develop their high proved evaporative and economic powers. It may be said that in the great majority of power and lighting stations, however, a saving of from 10 to 25 per cent. can easily be attained in the cost of operation and maintenance of steam boilers, would their proprietors only show a greater disposition to observe some of the fundamental principles underlying efficient boiler management. One of the chief factors to be sought in the promotion of economical boiler service is the attainment of a supply of pure and natural water; if this is overlooked endless trouble, annoyance and expense will inevitably follow from boiler incrustation, perhaps associated with corrosion and wasting away of the material which, more than all other causes combined, handicaps the usefulness of steam boilers, leads to explosions and consigns them, long before their time, to the scrap heap. A little calculation will show that a 100-hp boiler working 10 hours a day and 300 days a year and evaporating say 15 pounds of water per hour for each horse-power developed, and allowing 30 grains of solid matter in solution, the quantity of water evaporated will be 4,500,000 pounds, or 540,000 gallons, and the amount of solid matter 2314 pounds, or a little over a ton. This collected matter would, of course, exist in a boiler were it not removed regularly. All waters are more or less impregnated with dissolved and suspended impurities, and include common salt, sulphate of lime and several other constituents of rocks. When such waters containing dissolved and suspended impurities are fed to steam boilers, the fixed and non-volatile nature of these substances ensures their remaining behind in the boiler, and where subjected to high temperatures of heat, will finally become baked and firmly attached to the tubes and the shell, forming boiler scale, which prevents the water from coming into contact with the iron, and by resisting and obstructing the passage of heat to the water not only occasion a great loss of fuel, but imperil the boiler parts by causing bulging, blistering and bagging, leading also in a large degree to boiler explosions.

The extent of wasted energy brought about by incrustation is generally not appreciated. A scale of only one sixteenth of an inch in thickness will interpose so much heat between the iron and water as to require 12 per cent. more fuel than when the boiler is clean; while a scale of one-fourth of an inch in thickness will require an expenditure of more than double this quantity of fuel to perform the same duty as a boiler with a clean shell and tubes.

There is no more perplexing problem confronting power-station owners than the method by which to combat and prevent this condition. It is true the market is flooded with many articles containing 50 to 60 per cent. of harmful tannic acid mixed with grape and cane sugars, which generate acetic acid in the boiler water under steam, and further mixed with caustic alkali. Such materials are more harmful than boiler incrustation itself. Fluid vegetable extracts, which always contain predominating quantities of acids, mostly tannic acids, should never be used. In fact, all fluid articles should be handled with grave suspicion: They contain a large quantity of gummy and resinous materials, which interfere with the operation of the valves and other boiler accessories.

The writer has found that the most successful chemical re-agents employed include such chemicals as sodium fluoride, sodium tannate, tri-basic sodium phosphate and barium salts, etc., which should be carefully compounded together according to the analysis of the water to be purified. These salts chemically appropriate the acid part of the basic earths forming boiler incrustation and by converting them into soft snow-flaky precipitants which are held in suspension in the boiling currents of water prevent sedimentation and the formation of scale. Besides, these reagents will neutralize any acids present in the feed-water, which neutralizing action is of the utmost importance and is the only method by which to prevent corrosion. Of late years distilled mineral oils have been used a great deal, but as the evils attending their use are gradually becoming known, they are rapidly falling into disuse and disfavor. Aside from the danger incident to the presence of these inflammable oils, they invariably promote bad leakage of the boiler parts, the burning and crystallization of the material and the over-heating of the plates. Some engineers claim that when oil is intelligently used these evil effects can be obviated, but in the opinion of the writer their use is attended with so many bad results that they should be abandoned. These hydro-carbon oils are very penetrating as may be seen in the removal of rust from tools, and in penetrating the boiler joints they so lubricate these parts that the forces of expansion and contraction soon cause them to leak badly, thus bringing conditions which are a bane to all careful engineers. Oil also intends to throw down the scale in large fragments which accumulate over the furnace plates, producing over-heating, bulging and blistering, while seriously obstructing the circulation currents. Oil, when it works its way back of boiler scale, detaches the scale which falls off, thereby bringing into instantaneous contact the cold water in the boiler and the hot overheated places on which the scale was attached, resulting in such a dangerous molecular contraction on this part of the plate that it is liable to fracture.

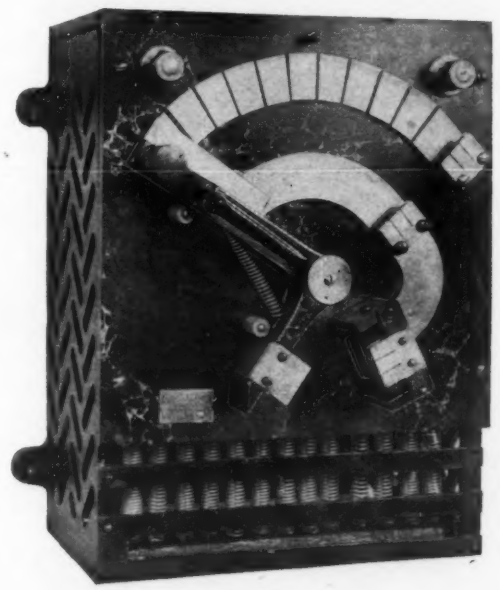
Every case differs and every remedy must differ likewise, so that it is only by advising with reliable experts that the best effects can be obtained.

Automatic Motor-Starting Rheostat.

The illustration given herewith represents a front view of a heavy-current motor-starting rheostat made by the American Rheostat Company, Milwaukee, Wis. Besides this type the company makes separate rheostats for light and medium currents; also a rheostat with automatic release and overload device for the protection of motors from overload, broken current, short circuit or lightning.

This device does away with the necessity for fuses and can be instantly set for any degree of overload up to 50 per cent. of the rated capacity of the motor.

The automatic motor speed regulating rheostat made by the American



MOTOR-STARTING RHEOSTAT.

Company is extremely simple in design, and the dynamo field rheostat is made in any required size.

The American Rheostat Company claims that its rheostats embody substantial advantages over the older types. They are simpler in construction and thoroughly practical and reliable in action. The length of the automatic brake is much greater than that of older forms and the constant arcing, it is stated, produces no damage whatever to contacts or slate.

The best of materials enter into the construction of these rheostats, and this combined with skilled workmanship enables the company to assert with confidence that its rheostats are second to none.

The rheostats are finished with marbleized slate front and japanned iron work, and are very ornamental in appearance.

Röntgen-Ray Apparatus.

Messrs. Elmer G. Willyoung & Co., Philadelphia, for which firm Mr. James G. Biddle, Drexel Building, Philadelphia, is sole selling agent, have been engaged for some time past in developing apparatus for practical Röntgen-ray work with particular reference to the needs of physicians and surgeons. They have adopted the single induction coil type of apparatus as distinguished from the high frequency or "Tesla" coil on account of its simplicity, ease of manipulation, cleanliness and noiselessness.

In Fig. 1 is shown one form of the induction coil. These coils are all

sectionally wound, the sections being but one eighth inch wide and separated from one another by insulating sections of about one fifteenth inch in thickness. The sections when assembled are subjected to a special insulating process unique with Messrs. Willyoung & Co., by which they are encased in a solid mass of high melting-point insulation compound from which air has been perfectly excluded. When air is present static electrification takes place, and the consequent bombardment of the insulation eventually softens and breaks it down. It is claimed that these coils are the only ones made embodying this valuable point. By it the usual loss of energy in the secondary, due to static electrification and general leakage, is greatly lessened, and the entire energy of the spark is available at the secondary terminals.

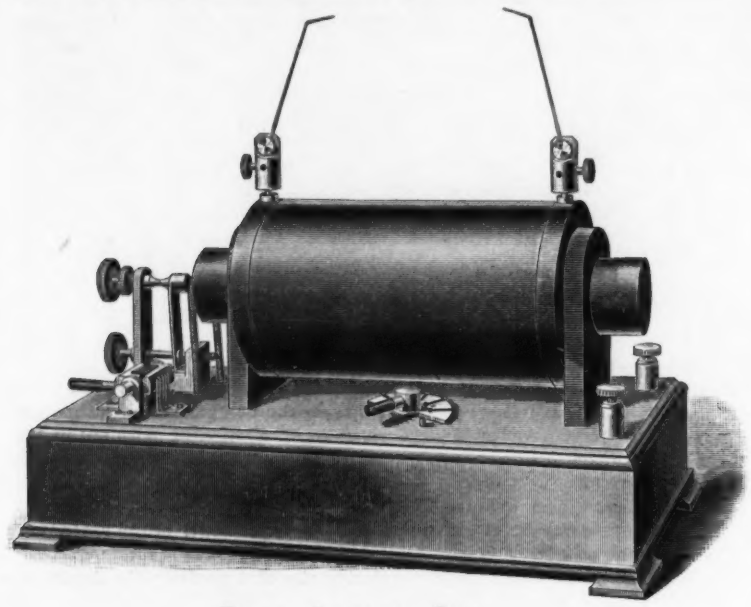


Fig. 1.—Induction Coil.

With the increasing use of Röntgen-ray plants in hospitals and public institutions has come a demand for a means of running the induction coil from ordinary commercial lighting circuits, and until recently this has been impossible, save on very small coils. To meet these conditions Messrs. Willyoung & Co. have devised the form of rotary break shown in Fig. 2. It consists of a small $\frac{1}{2}$-hp motor with vertical shaft. Above the motor is held, by a suitable casting, a can made up of two concentric cylinders joined by a ring. The motor shaft passes up through the central cylinder, a stuffing box being thus avoided. A break wheel made up of heavy brass casting, with a section of slate let into its periphery, is hung from the motor shaft and revolved by it. It lies well down in the can which is filled with distilled water when in use. A hard rubber lid carries the brushes and covers the can so as to prevent any rise of the water. The break wheel has three makes and breaks per revolution, and may be run up to 2000 revolutions (6000 interruptions) per minute. This rate of interruption may be varied by means of an adjustable rheostat concealed in the base of the break and operated by a little slider. A condenser is placed about the terminals of the break. Current up to 15 amperes or over may be broken through this break during as long a time as may be desired.

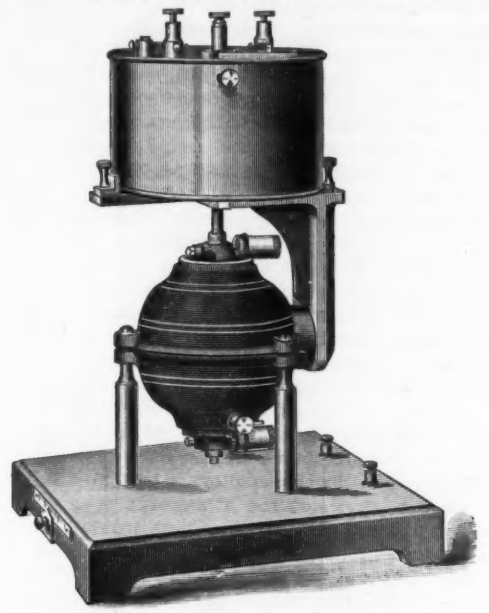


Fig. 2.—Rotary Break and Motor.

To meet the needs of hospitals and public institutions the complete Röntgen-ray generator shown in Fig. 4 has been devised. Here the coil, rotating break, condenser, etc., are all mounted upon one base. The secondary and spark points are adjustable. A Carpenter rheostat in the base of the apparatus regulates the amount of current passing through the primary of the coil, while the motor break regulator is operated by a projecting rod, as shown. To guard against accidentally throwing off the break while the coil circuit is still on, the W-S interlocking switch has been devised. This arrangement makes the apparatus perfectly safe against short circuits, while at the same time preventing the annoyance of frequently replacing fuses otherwise "burnt out." A plug is provided for connection with a lamp socket.

The adjustable condenser is a very valuable feature of the Willyoung coils. It is shown as combined with a coil in Fig. 1. A pivoted switch allows a greater or less number of sections to be thrown in as desired. By thus varying the condenser capacity the coil is brought into a condition of resonance to adapt its discharge to the tube in use.

After considerable investigation of the merits of vacuum tubes Messrs. Willyoung & Co. finally decided in favor of the "Bowdoin" tube and made arrangements with its inventors, Profs. Robinson and Hutchins, of Bowdoin College, by which they became sole manufacturers. This tube which is shown in Fig. 3, is claimed to be practically unvarying in its vacuum and not to blacken. It is said to be always ready for use and to instantly start off at full efficiency. The tube has also very remarkable penetrating powers.

Fig. 3.—Röntgen-Ray Focus Tube.

Fig. 4.—Röntgen-Ray Machine.

In Fig. 5 is shown Willyoung & Co.'s universal stand devised for support of the tube. By its use a tube may be placed in any position within

FIG. 5.—UNIVERSAL METAL STAND.

a cylindrical space six feet in diameter and six feet high. The stand is made of bicycle tubing and is very rigid under all circumstances.

The "Booster" Patent.

A patent, apparently very broad in its scope, was issued on Dec. 8 to Mr. H. Ward Leonard, covering in its most recent form what has become known during late years as the "booster" system, and owing to the important postion held by the system in electrical engineering practice a more than passing notice of the matter may by justifiable at this time.

The applications of the "booster" system have reached into nearly all fields of modern electrical engineering. We find the "booster" in use in the feeders of incandescent lighting systems for controlling the E. M. F. at the feeder terminals. It is also used for controlling the E. M. F. upon railway circuits, especially for long-distance work, also for controlling the charging and discharging current of storage batteries used in connection with lighting and railway circuits, and many engineers seem to feel that the applications of the "booster" principle will be extended even more widely in the immediate future.

There were no less than 13 interferences in this case and during the many years that this controversy has been pending in the Patent Office the uses of the "booster" for the regulation of E. M. F. for various purposes have been steadily increasing and the issuance of a broad patent on the subject will come as a surprise to many who have supposed that the features of the modern "booster" were the outgrowth of evolution rather than a specific invention.

For the benefit of those of our readers not fully familiar with "boosters" we will explain that in its commonest form a "booster" consists of two dynamo-electric machines having their armature shafts mechanically coupled together and each armature being in a separate field. One end of the "booster" is usually a shunt-wound machine which is connected directly across the constant E. M. F. circuit and which consequently runs at a practically constant speed. The other end of the booster has its armature inserted in the path of the main current; for example, in a feeder of a lighting system. The field in which this regulating armature revolves may be regulated independently of the pressure upon the lamps or other translating devices so that the E. M. F. produced by this regulating armature can be varied positively and thus the E. M. F. upon the feeder terminals can be held at the desired point even though the "drop" in different feeders varies widely.

The field winding for this regulating armature is sometimes series-winding with a variable shunt for regulating the E. M. F. produced by the armature. Sometimes it has a winding identical with that of a shunt machine, but the field winding being connected across the constant E. M. F. circuit instead of upon the terminals of its own armature and having a rheostat in circuit so as to vary the field strength and consequently the volts produced by the regulating armature of the "booster."

The most economical method of use, however, is to connect the field as in the last case, directly across the constant E. M. F. circuit, but to put in circuit with the field winding a reversing field rheostat. By this arrangement the regulating armature of the "booster" can be made to not only assist or "boost" the E. M. F. of the main source, but also by reversing the field magnetism it can be made to oppose the E. M. F. of the source and thus reduce the E. M. F. at the translating device below that of the main source.

In this way an armature of, for example, 10 volts can be used so as to cause a regulation at the lamps of 20 volts which, of course, means that such a "booster" would be only one half the size of a "booster" without the reversible E. M. F., and with a corresponding saving in first cost and efficiency.

For controlling storage batteries the use of this "plus and minus booster" has of late almost entirely supplanted the former method of using rheostats and "regulating end cells" for controlling the current through the battery under conditions of charge and discharge.

Upton Long-Burning Lamp.

The Standard Thermometer & Electric Company, Peabody, Mass., has always endeavored to meet promptly any improvements in arc lamp manufacture, and with the advent of the long-burning arc lamp it commenced to experiment in this direction, finally producing a lamp of this nature, which it claims has such superior qualities as to command quick success. The new long-burning lamp this company now presents, and

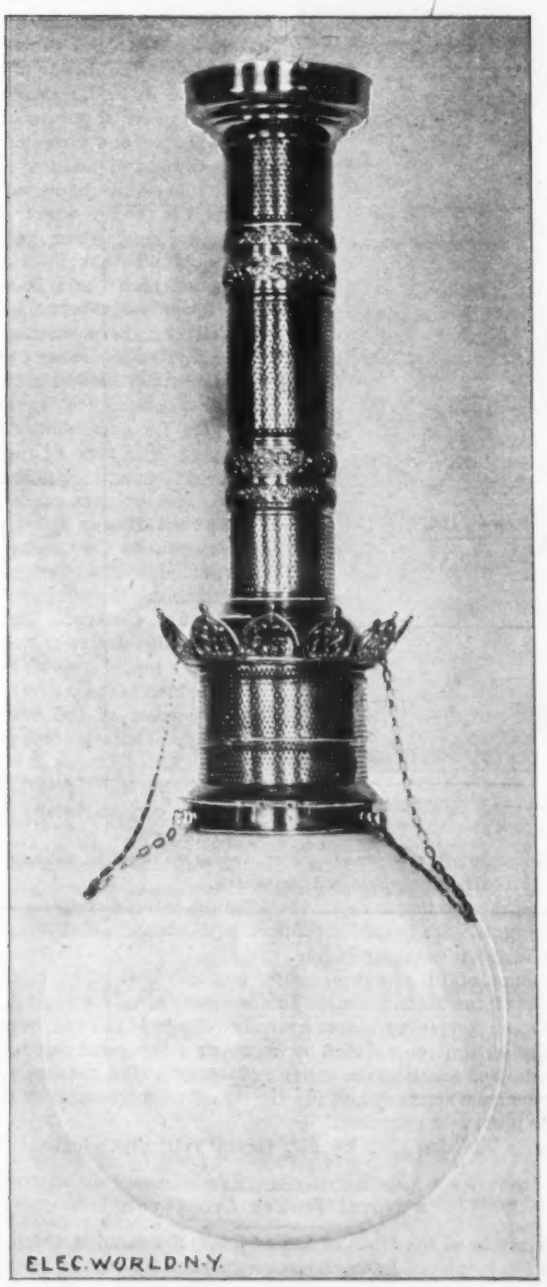


FIG. 1.—UPTON ARC-LAMP.

which is illustrated herewith, is beautiful in appearance, and combines perfect steadiness of burning and light. It encroaches upon important footholds of the incandescent lamp, in that in its construction it permits of satisfactory operation whether made 12 or 36 inches in length

thus admirably adapting it for show windows, low ceilings, etc. The lamp is made in 11 parts, including resistance, inner globe, outer globe and cover.

The central feature is a brass pipe which acts as a support for the solenoid, guide for the carbon holder and cylindrical armature, and at the same time is the skeleton or frame for the lamp. The solenoid, which is a perfectly ventilated magnet, is made large enough to admit of its being easily slipped over the top of the brass pipe, and rests on a ventilated shoulder on the pipe.

The cylindrical armature, which acts as carbon rod, controller of the arc and dash pot, is made of a metal influenced by magnetism and threaded at the lower end so as to receive the carbon holder and travels inside of the brass pipe.

The upper carbon holder, which is screwed to the end of the cylindrical armature, is a new and entirely novel feature. The carbon is slipped into the clamp, which automatically makes a good contact and positive alignment. The construction of the carbon holder is such as to provide for any expansion or contraction developed in the lamp, and makes it impossible for the carbon to drop out.

The cap is screwed onto the top of the brass pipe and makes an air-tight joint, also serving as the base to which the insulating lamp hanger is attached. This cap extends downwards in the shape of a rod, at the lower end of which is an enlargement which serves as a plunger for the dash pot.

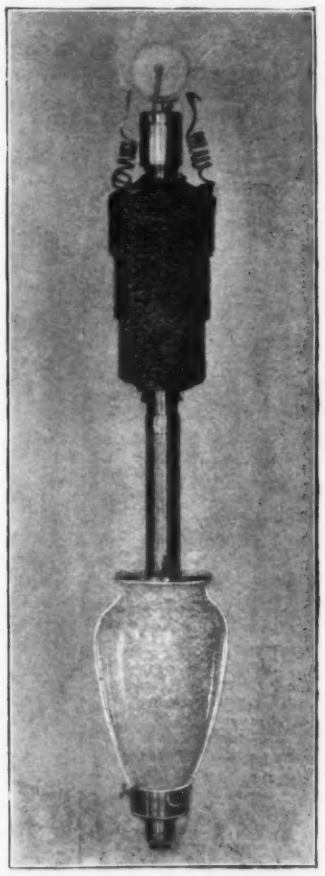


Fig. 2.—Upton Arc Lamp.

The support for the inner globe is provided with a threaded hole and is screwed onto the thread on the base of the brass pipe, thus making an air-tight passage for the carbon. The lower portion is flange shaped and threaded on the inside to receive the inner globe.

The inner globe is provided with a thread at the top which fits into its holder and when in position forms an air-tight joint between the inner globe and its holder. The lower carbon-holding device also serves to hermetically seal the lower part of the inner globe, and like the upper carbon holder automatically aligns the carbon and provides for expansion and contraction. The turn of one thumbscrew at the same time fastens the carbon and seals the inner globe.

The resistance is fitted beneath the solenoid to the brass pipe, and is provided with a changeable cut-out, enabling the lamp to burn on a variable voltage. The outer globe has no opening at the bottom and at the top is provided with a clamp which holds it firmly to the lower portion of the cover, thus forming a shadowless support.

The salient features of this lamp, to which the manufacturers invite attention, can be briefly summed up as follows:

It is absolutely free from mechanism; it has no parts to wear or become gummed; no carbon or guide rods to polish.

In placing the resistance under the solenoid, instead of above and close to the ceiling, the fire hazard is reduced to a minimum and objections of insurance inspectors are overcome.

The absence of all clutches, gears, frictions and other methods for escapement of the carbon insures an absolutely steady white light. The arc controlling device maintains a steady voltage at the arc, overcoming the blue-tinted light occasioned by improper escapement mechanism.

The method of securing the inner and outer globe renders the lamp entirely free from shadow, and the trimming arrangements of the lamp reduce the labor to a minimum.

This lamp was designed by Mr. Henry Hallberg, electrician for the company.

A Novel Trolley Crossover.

An illustration of the truth of the adage, "Necessity is the mother of invention," is furnished in the ingenious method by means of which the engineers of the Hingham Street Railway, of Hingham, Mass., overcame an obstacle this Summer in the form of the trolley wire of the New York, New Haven & Hartford Railroad. The Nantasket Beach branch of the latter road was formerly a steam railway but is now operated on the trolley system, and current is, by this means, furnished at a high voltage to large motor cars. The rival street railway and the Nantasket Beach Road intersect at three points of their lines. The officials of the latter, using as an argument the difference of potential between the two trolley wires, entered into litigation which resulted in a decree of the court prohibiting the installation of any form of the many admirable and safe patent trolley crossovers commonly used at the intersection of street railways. As a result the engineers and constructors of the Hingham Street Railway adopted the following plan:

Two heavy poles were erected along the line of the street railway, one on either side of the tracks of the Nantasket Beach road and as close to them as allowable. On each of these poles at a distance of 18 feet above road grade was bolted trussed iron brackets, to which the railway trolley was anchored on either side of the Nantasket Beach line. This left unobstructed the space above the tracks of the latter. To complete the trolley connection of the street railway a counterpoised "gate," swinging in a horizontal plane, was pivoted in a ball bearing upon one of the brackets. The lower member of the "gate" carried a light steel channel which received the trolley wheel when the gate was swung into position. A tap wire connected the trolley wire and the trough.

Upon the arrival of a street car on the spot the conductor turned a lever at the base of the pole, swinging the gate into position. After the car passed over, the gate swung itself back to its place parallel to the tracks of the Nantasket Beach line and out of the way of travel on either road. Although a makeshift, and a very expensive one at that, the device was successful as far as such a roundabout method could be. In every way inferior in convenience, durability and safety to the many patent trolley crossovers on the market, the swinging trolley gate was, nevertheless, a very ingenious solution of a problem developed by the unfortunate circumstances attending the case.

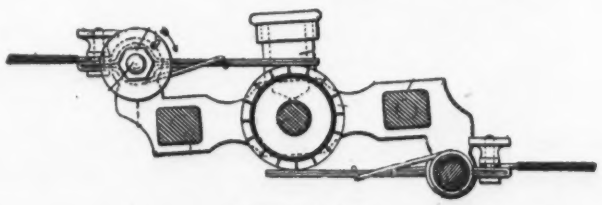
Fan Motor.

The North American Electric Company, 181 William Street, New York City, is manufacturing a type of fan motor which promises to find a large sale during the coming season. This machine is substantially constructed of the best material, and the North American Company claims that it is the most efficient motor on the market. The motors may be used for other power purposes in addition to the operation of fans. In running sewing machines they are doing excellent work and are meeting with an increasing demand for this particular use; they have, also, a promising outlook for dental lathe work. For the operation of kinetoscopes these motors have been used for several years with satisfaction.

A new bracket recently put upon the market by the North American Company is an admirable device for directing a current of air to any part

Motor Bracket.

of the room. It is the invention of Mr. Fuller, of the company. It consists of a substantial plate of brass or iron supporting a table hinged to a vertical post resting in sockets projecting from the plate. The motor being placed upon the table may be swung around in any direction and tilted at any angle by the aid of a thumb screw. This bracket may be used in connection with any make of motor and for other purposes. The



Brush-Holder.

new patented brush holder brought out by the company last season has proved to be an excellent improvement and is a very desirable feature of its motor. The pressure of the brush upon the commutator is easily regulated and any desired tension may be readily obtained. The brushes are removed and renewed with facility, and those who have had annoying experiences with brushes will no doubt appreciate the advantages offered by the North American Company's improvement.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Dec. 19, 1896.

ELECTRICAL STOCKS.—Weakness characterized the entire list, and declines were general. General Electric closed with a loss of 1½, as compared with the last quotation, while the preferred stock remained unchanged. Westinghouse preferred advanced 1 point, Storage Battery, common and preferred, both lost about 1 point.

TELEGRAPHS AND TELEPHONES.—Telephone stocks are the only ones that show any improvement over last week's quotations, while the telegraphs were all weak. Bell telephone advanced ¾ of a point, closing at 210 bid, New England 1½, closing at 103. Western Union suffered a sharp decline, closing at 82 bid, which price is 4½ points lower than last week's closing quotation.

TRACTIONS.—The market for street railway securities was featureless during the week, declines being the rule. The only exceptions were North Shore Traction preferred, and Union Railway (Huckleberry), the former advancing 2 points and the latter 1. Brooklyn Rapid Transit stock dropped 1 point; Buffalo Street Railway, 1; Columbus Street Railway, 2; New Orleans Traction, 2; West End, common, 1¼, and West End, preferred, 2.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	..	..
Edison Electric Ill., New York	100	99	101½
" " " Brooklyn	100	88	93
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	27	28
Electric Storage, pref	100	29	30
General Electric	100	30½	30⅞
General Electric, pref	100	..	73
Westinghouse Consolidated, com	50	25	..
" " pref	50	51½	52

BONDS.

Edison Electric Ill., New York	105	106	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	92½	..

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	210	..
American District Telegraph	100	*29	39
American Telegraph & Cable	100	85	90
Central & South American Telegraph	100	124	127
Commercial Cables	100	150	172
Erie Telephone	100	65¼	66¼
New England Telephone	100	103	..
Postal Telegraph-Cable	100	92	94
Western Union Telegraph	100	82	82½

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	17¼	17½
Brooklyn Rapid Transit		18½	20
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	76	78
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	41	43
Hestonville	100	51	51¼
" pref		..	62½
New Orleans Traction	100	10	12
" " pref	100	40	50
North Shore Traction	100	21	24
" " pref	100	77	80
Rochester St. Ry	..	17	20
Steinway Ry	..	45	50
Union Railway (Huckleberry)		99	.
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	65½	66
" " pref	100	85	..
Worcester Traction	100	19	21
" " pref	100	92	95

BONDS.

Brooklyn Rapid Transit 5s. 1945	100	78¾	..
Buffalo St. Ry. 1st con. 5s	100	*107	109
Cleveland Elec. Ry. 1st mtge 5s	100	102	104
*Columbus St. Ry. 1st 5s	100	94	96
Rochester St. Ry. 1st 5s	100	..	98
Union Railway (Huckleberry) 1st mtge 5s		*102	105
*Westchester Electric 1st mtge 5s	100	100	103

* With accrued interest.

DIVIDENDS.—The Edison Electric Illuminating Company of New York has declared a quarterly dividend of 1⅛ per cent, payable Feb. 1, 1897.

The American Bell Telephone Company has declared a quarterly dividend of 3 per cent. and an extra dividend of 1½ per cent., payable on Jan. 2 next.

THE EDISON ELECTRIC ILLUMINATING COMPANY OF NEW YORK reports gross earnings for November of $225,529.40, an increase of $33,491.68 as compared with the same month in 1895. The net earnings were $123,883.32, an increase of $29,930.96.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Dec. 21, 1896.

COLUMBIA UNIVERSITY.—We have received from Columbia University a set of five pamphlets announcing the courses of study in the Schools of Mines, Chemistry, Engineering and Architecture, and giving general and interesting information concerning the same.

LARGE PLANT PROJECTED.—It is reported that the Edison Electric Illuminating Company of Brooklyn, has purchased a plot of ground on the water front of Brooklyn for $260,000. The company intends, it is stated, to construct an electrical generating plant of an aggregate capacity of 120,000 horse-power. The building and machinery will cost $300,000.

T. J. MURPHY & CO., 511 West Thirteenth Street, well known manufacturers of switchboards and other electrical supplies, made an assignment on Dec. 11, to Fred Hulse of Monroe, Orange County, N. Y., giving a preference to the Eureka Tempered Copper Company, of Northeast, Pa., for $1507. The liabilities of the firm are reported to be $7000. The business was started in 1892.

ELECTRICAL WIRES ON THE BROOKLYN BRIDGE.—According to the report of the Brooklyn Bridge trustees for the year ending Dec. 1, 1896, 796 electric wires and two cables are laid across the East River on the Bridge. Of these wires 714 are telephone, 55 Western Union Telegraph, 10 Postal Telegraph and 10 Gold & Stock. The number of wires in each of the two cables is not stated. The rental received for these privileges amounted to $23,884.76, of which the New York Telephone Company paid $20,824.76; the Western Union Telegraph Company, $1,650 and the Postal, $400

THE ELECTRICAL TRADES SOCIETY of New York, has made such excellent progress that the Executive Committee and the members look forward to a large field of usefulness for the organization. The admission fee has been increased to $50, but as the annual dues are but $25, which covers all the expenses, the cost of the valuable information furnished by the society is comparatively very slight. Kindred societies in Boston, Chicago and other cities are arranging to exchange information with the New York society, so that all the members in the different cities will benefit by this mutual interchange. Manufacturers and wholesale dealers who have accounts with contractors, supply dealers and others connected with the electrical trade will do well to communicate with Mr. A. P. Eckert, the secretary, at 229 West Twenty-eighth Street, New York City, from whom they can obtain information as to the society.

PHILADELPHIA NOTES.

Branch Office of THE ELECTRICAL WORLD,
927 Chestnut Street,
PHILADELPHIA, Pa., Dec. 18, 1896.

THE KENSINGTON ENGINE WORKS, Ltd., whose main office and works are at Philadelphia, Pa., have opened a branch office at 74 Cortlandt Street, New York City.

NEW GENERAL MANAGER OF THE UNION TRACTION COMPANY.—At the meeting of the Board of Directors of the Union Traction Company, held a few days ago, Mr. John B. Parsons was unanimously elected vice-president and general manager. Mr. Parsons at present occupies a similar position with the West Chicago Street Railway Company and will assume his new duties in Philadelphia about Jan. 1. He began his career at the bottom of the ladder, and in 1870 was a conductor on the Darby branch of the Chestnut and Walnut Street horse car line.

BUFFALO AND NIAGARA FALLS NOTES.

BUFFALO, N. Y., Dec. 18, 1896.

A NEW NIAGARA POWER PLANT.—There is a talk of another power plant in the gorge. H. C. Haskins & Co., of New York, and C. H. Haskins, of Buffalo, were here recently, and went down the gorge to the whirlpool, making measurements and computing the force of the water at several places. They went to Buffalo to have a conference with Capt. Brinker and others interested in the Gorge Railroad regarding a permit to develop the power. The Gorge Railroad Company has been offered inducements to allow the New Yorkers to go ahead with the work, and it is safe to say that electricity will be generated at Devil's Hole. The plan is to start in on a small scale, build a power house large enough to turn out 15,000 horse-power and then add to it as the circumstances demand. If the co-operation of the Gorge Railroad Company is obtained, a power company will be organized of New York and Buffalo capitalists and the work will be carried on with all the speed possible. In making the surveys platforms were bolted upon the rocks 25 feet from shore, and on these platforms the water motors were tested. Men who had patent wheels worked from early in the morning till late at night, not even stopping when the sun went down.

PROPOSED DEVELOPMENT OF POWER ON THE CANADIAN SIDE.—It is announced that the Cataract Construction Company, the parent of the Niagara Falls Power Company and the Canadian Niagara Power Company, will shortly begin work on the construction of a tunnel on the Canadian side of the Niagara River, to develop 25,000 electrical horse-power. By the terms of the contract with the Canadian authorities the privileges granted will lapse in 1897 if some work has not been done in the meantime. The engineering corps it is stated, will soon be engaged making the necessary preliminary surveys and work will be pushed when once begun. That there will be industries to utilize the power is already an assured fact. The Pittsburg Reduction Company has secured a site in the neighborhood and the Carborundum Company announces that it will erect a plant on the Canadian side in the Spring. President E. G. Acheson, of the Carborundum Company, states that his company is practically forced to establish a plant on Canadian soil in order to protect its Canadian patents. The company, it is stated, was doing a large business in Canada, when the Government stepped in under the provisions of the Patent Law and forced the company to either abandon its trade or give up its patents. The plant to be erected on the Canadian side will require about 200 electrical horse-power.

THE CARBORUNDUM COMPANY'S works on the American side of the river are running full time and producing about 4000 pounds a day. The largest carborundum wheel ever made is now being turned out at the works. It is 36 inches in diameter and is being manufactured for the Howe Scale Company of Vermont. It is stated that carborundum is entering new fields, and will in the near future replace garnet cloth, which is used in polishing off the soles of shoes. It is also announced that carborundum is to replace ferro-silicon in the steel industry. Ferro-silicon is used to strengthen and harden steel, and in Germany alone it is estimated that 2440 tons is annually consumed by the steel manufacturers. It is stated that the superiority of carborundum over ferro silicon for this purpose has been established. Mr. E G. Acheson has, it is stated, devised a method of producing graphite and pure carbon in the electric furnace, which products are largely used in the manufacture of electric light carbons, etc. A plant will be erected in Niagara Falls, N. Y., for the manufacture of these substances and one will be erected on the Canadian side for the same purpose. Mr. Acheson, it is stated, in his new system develops graphite from carborundum. This is done by subjecting the carborundum to a much higher temperature in the electrical furnace than is required for the production of the carborundum itself. It is really the result of the decomposition of the carbide. The pure carbon is produced by subjecting coke or impure carbon to a temperature in the electrical furnace sufficiently high to volatilize the ash or other impurities present. The company will simply produce the new carbon, leaving its manufacture to existing concerns.

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, ILL., Dec. 17, 1896.

MR. A. O. SCHOONMAKER, New York, the well-known importer of India and amber mica, in order to meet the demand from his Western trade, has opened an office in the Monadnock Building, Chicago, and will be represented there by Mr. John Child, who will carry a full stock of all grades of mica and will be prepared to fill orders promptly.

MR. G. W. CONOVER has resigned his position as manager of the Perkins Electric Switch Manufacturing Company's Chicago office, which position he has creditably filled for the past three years. He has not announced what he will engage in during the coming year, further than that he will remain in the electrical business. Mr. Conover is one of the pioneers in the electrical field, and has been engaged in its various branches for the past 15 years.

MR. E. W. HAMMER, of the Cutler-Hammer Manufacturing Company, Chicago, has disposed of his controlling interest in that concern and will sever his connection with that company on Jan. 1, 1897. It is his intention to take a long and much needed rest, with the expectation, however, of continuing permanently in the same branch of the electrical business. Mr. Hammer states that he will always take a lively interest in the Cutler-Hammer Company's welfare, and hopes that it may receive an increasing share of the courtesy and patronage with which it has been so freely favored in the past by the electrical business world.

ST. LOUIS NOTES.

ST. LOUIS, Dec. 18, 1896.

OPENING OF BIDS FOR CITY LIGHTING.—April 9 has been set as the day on which will be opened the bids for lighting St. Louis for 20 years from Jan. 1, 1900.

NEW STREET RAILWAY.—The South Broadway Merchants' Association reported through the Railway Committee, and the report was adopted, that an incorporation be formed to secure a franchise and build a street railway over a route to be decided on later. The capital stock will be $6000, divided into 2000 shares of $3 each. The members of committee will subscribe for 1800 shares. The association through a trustee will subscribe for the remaining 200 shares. The road will be known as the South Broadway Merchants' Railway Company.

LIGHT CONTRACT IRONCLAD.—The contract for lighting the city will tie the contractor's hands. If he takes the job at unprofitable figures and gives imperfect service, he will lose his contract and have his plant confiscated unless he remedies matters. He will be fined 10 cents per day for each incandescent lamp ordered and not put up, and 50 cents for each arc light. No pay can be drawn for lamps "out of service," and any incandescent lamp of less than 32 candle-power, and any arc lamp of less than 700 candle-power will be "out of service." All lamps not changed within 30 days after change is ordered will be considered "out of service." A bond of $100,000 is required in addition to 5 per cent. kept out of monthly payment, until a fund of $100,000 has been accumulated, which is designed to additionally protect the city against damage. The contractor must begin the construction of his conduits and plant within 90 days after contract is approved.

NEW LIGHTING CONTRACT.—The Supervisor of City Lighting, Mr. A. J. O'Reilly, gives the following interesting information in regard to the new lighting contract: There are 2268 arc lights in operation on the streets, and 257 more have been ordered. There are 1329 incandescent lights on the streets, and 2376 are in alleys and parks. The total length of streets now supposed to be lighted is 500.79 miles, and 90 miles of streets will require lighting, in addition to above, within a few years. To accomplish this and replace the incandescent lights on the streets 1451 lights, in addition to the above, will be required to do the work thoroughly. If the alleys are to be lighted by arc lights, 938 more will be required, and 100 for parks, making a total of 5011 arcs. Of the above arc lights 2921 may be replaced by about 17,526 incandescent lights and 2090 should be replaced by 6840 incandescent lights, so that if incandescent lights are to be substituted throughout for arc lights, about 24,366 lamps will be required. For use of arc lights on business streets or streets traveled by street railways and at intersection of steam railways with public streets, 2921 arc lamps will be required. The lighting of residence streets, alleys and parks may be accomplished with about 6840 incandescent lamps.

CANADIAN NOTES.

MONTREAL, CAN., Dec. 18, 1896.

NEW ELECTRIC LIGHT PLANT.—An electric light plant is to be established in Shawville, Que. The town has offered 20 years' exemption from taxation.

MUNICIPAL PLANT.—The City Council, of Chatham, Ont., has decided to submit a by-law providing for the expenditure of $15,000 in the purchase of a civic electric light plant.

TELEPHONE EXTENSIONS.—The Canadian Telephone Company proposes to extend its line from Scotstown, *via* Milan and Marsboro to Lake Megantic village. Electric light is also talked of for the village.

PURCHASE OF TELEPHONE PLANT.—J. F. McLaughlin, late of Toronto, has purchased the charter of the Spokane & Columbia Telephone Company. He intends to put in a system at Rossland, B. C., first, then to extend it to Trail and from that point to Spokane.

THE RENFREW ELECTRIC LIGHT & POWER COMPANY, Ltd., is applying for an Ontario charter. The place of business is to be at Renfrew, Ont., capital, $90,000. The applicants are W. A. Mackay, A. A. Wright, W. T. Guest, A. C. Mackay, H. Wright, Renfrew.

CHANGES IN PLANS.—Some changes have been made in the plans of the Cataract Power Company, of Hamilton. It has been decided not to acquire DeCew's Falls, but to cut across the country for a short distance with the water course. Prof. Paterson has made satisfactory arrangements with the St. Catharines Water Commissioners. The Cataract Company has closed contracts to supply power to the Hamilton Electric Light Company, and has applications for terms from a number of other companies.

OTTAWA, ONT., Dec. 18, 1896.

THE PARK & ISLAND RAILWAY COMPANY expects to have the power house at Lachine and St. Laurent in operation within 30 days. The line to Cartierville is also complete, so far as the tracks are concerned, and the overhead work is now being constructed. This line will be put in operation in a month's time.

ELECTRIC RAILWAY SYNDICATE.—A syndicate has been formed in Hamilton, Ont., for the purpose of purchasing the various electric roads running out of Hamilton and also the Hamilton Street Railway. The Hamilton Radial Electric Railway and the Hamilton, Grimsby & Beamsville Electric Railway held their stock at a high figure, but the syndicate proposes to make a stiff bid for it. Mr. MacKenzie and Mr. B. B. Osler, of the Toronto Street Railway, are at the head of the syndicate.

DUTY ON RAILS.—The case of the Toronto Street Railway *vs.* the Queen was before the Exchequer Court at Ottawa this week. It arises out of the question of the liability of steel rails to pay duty. The Exchequer Court, in the original case, decided against the appellants, and this judgment was sustained by the Supreme Court. The Judicial Committee of the Privy Council, England, reversed both decisions, but did not state the amount to be paid to railway company. A motion was then made in the Exchequer Court to fix the amount and award interest. Justice Burbidge decided that the judgment could not carry interest, and gave judgment in favor of the Toronto Street Railway for $56,044.17.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Dec. 16, 1896.

ELECTRIC LIGHTING AND TRACTION ENTERPRISES.—*The Electrician*, in accordance with its usual custom, gave in its issue of Dec. 4 a complete list of the new electric lighting and traction enterprises advertised, according to law, in the *London Gazette*. This year there are 61 electric traction notices and 61 electric lighting notices, as against 37 and 41 respectively last year. Apart from the unusually large totals, there is considerable probability that a larger proportion than is customary of the schemes here foreshadowed will mature.

THE DAVY-FARADAY RESEARCH LABORATORY.—The Prince of Wales has consented to open the Davy-Faraday Research Laboratory on Tuesday, Dec. 22. This laboratory, it will perhaps be remembered by your readers, has been founded by Dr. Ludwig Mond, F. R. S., in connection with the Royal Institution, as a memorial of the work done there by Davy and Faraday. The ceremony will take place in the theatre of the Royal Institution, where, at the special request of the Prince, Prof. Dewar will, after the opening ceremony, show some experiments illustrative of the use of liquid air in scientific research.

THE LONDON TRAMWAYS QUESTION.—The London County Council has actually taken a definite step forward in this matter. At its meeting held recently it decided, after a lengthy, but by no means lucid, debate, to adopt the general idea of purchasing for a sum of £675,000 so much of the tramways in the North of London as are within its jurisdiction, and to subsequently lease the system to one of the companies now operating. The terms of the lease are that the operating company shall pay the County Council a fixed annual rental of £45,000, and in addition to this 10 per cent. of the increase of the gross receipts above the figure obtained in 1895. Furthermore, if electric traction is adopted, the County Council is to have no less than 80 per cent. of any balance that may remain in hand after the payment of interest upon the further capital outlay, at a certain specified rate. It cannot be said that from the point of view of the electric traction engineer this decision of the London County Council is a particularly favorable one. However, we must be thankful that electric traction is so much as contemplated. No doubt, from the electrical point of view, it would have been better if the County Council had decided, as suggested, to straightway purchase the entire tramway system of London and lease it to a powerful syndicate upon the condition that some approved form of mechanical traction was adopted. And it would, perhaps, have been better still if the existing companies had been granted long extensions of their leases upon the condition that they moved with the times in the matter of traction.

THE TELEPHONE TRUNK WIRE SYSTEM OF THE UNITED KINGDOM.—The discussion on Mr. J. Gavey's paper on this subject before the Institution of Electrical Engineers, which was brought to a conclusion at the last meeting was of a somewhat disappointing nature. As there are practically no competent telephonists in this country outside the Post Office and the National Telephone Company, and as these two are now practically one concern, the majority of the speakers naturally did not indulge in anything like searching criticism, but contented themselves for the most part with blessing the Post Office system. No doubt this is very excellent and there is no doubt whatever that considerable thought and skill have been applied to working out the demonstrative and mechanical details. At the same time it would be more satisfactory to hear competent criticism from independent telephonists of experience. As it was, however, two speakers raised questions of some importance, but did not meet with very satisfactory replies from Mr. Gavey. One gentleman was anxious to know what was the law which governed the Post Office in its choice of the gauge of copper for its trunk wires. This information would be especially valuable from a public point of view, since the Post Office has been most lavish in its outlay on copper, far more lavish than the National Telephone Company. Of course, the Post Office has a more ambitious object in view, *viz.:* that any subscriber in any part of the United Kingdom should, without appreciable delay or difficulty, be able to speak with any telephone subscriber in any other part of the United Kingdom. When one of the subscribers happens to reside in Ireland this will involve speaking through a submarine cable from 25 to 50 miles in length and probably through two or three trunk exchanges, so that heavier copper is naturally requisite in the case of the Post Office wires than in the case of the National Telephone Company's lines. However, it would be reassuring to know that economy has not been lost sight of in this connection. Prof. Ayrton was also anxious to know exactly what the Post Office engineers mean by wire-to-wire capacity, and how they measured the relative intensities of electrostatic and electromagnetic disturbances. Here again, the reply was somewhat ambiguous, and although the matter is of considerable importance, electricians outside the Post Office are still in the dark.

General News.

NEW INCORPORATIONS.

THE LIMA ELECTRIC STREET RAILWAY COMPANY, Lima, O., has has been formed by E. W. Moore, N. A. Gilbert, Adam Y. Hill and others. The capital stock is $200,000.

THE ALBO-CARBON LIGHT COMPANY has been incorporated at Trenton, N. J., with a capital stock of $250,000. The incorporators are James Kedd, Charles W. Bryden and Frank J. French.

THE MONMOUTH COUNTY TELEPHONE COMPANY, Asbury Park, N. J., has been incorporated with a capital stock of $100,000 to do business in all the towns and villages in Monmouth County.

THE STAR ELECTRIC COMPANY has been incorporated at Binghamton, N. Y. The incorporators are G. S. Beach, Clarence E. Beach, Samuel H. Chaut and Herman V. Doughty, of Binghamton. Capital stock, $100,000.

THE CALHOUN TELEPHONE COMPANY, Hardin, Ill., has been incorporated with a capital stock of $3150. The incorporators are Thomas J. Selby, David A. Smith, Paul Friedel, John B. Sutter and William F. Subbrack.

THE EGG HARBOR CITY ELECTRIC LIGHT, HEAT & POWER COMPANY, Egg Harbor, N. J., has been formed with a capital stock of $10,000. Those interested are H. L. Siggins, Bingham Hood and Daniel W. Green.

THE BEREA TELEPHONE COMPANY, Berea, O., has been organized by M. A. Sprague, A. A. Loomis, H. T. Luster, T. C. Matison, O. D. Pomeroy, T. G. McCauley, T. D. Carpenter, A. H. Pomeroy and M. E. Bollis. The capital stock is $10,000.

THE GEORGE WASHINGTON MINING COMPANY has been formed in Trenton, N. J., with a capital stock of $2,000,000. Those interested are James C. Maguire, of Brooklyn; Maurice J. Power, of New York, and Charles U. King, of Jersey City, N. J.

THE WINNEBAGO CONSTRUCTION COMPANY has been incorporated at Oshkosh, Wis., with a capital stock of $90,000. This company will succeed the Citizens' Traction Company recently formed, and will build an electric line in this city and later from here to Kaukauna.

THE CHESTER COUNTY CENTRAL RAILROAD COMPANY, Chester, Pa,, has been organized by William S. Kirk, of West Chester; John S. Deve, Jr., Archibald R. Dewey, Frederick W. Rush, Joseph B. Willits, of Philadelphia, and A. Oliver Winchester, of Narberth. It is proposed to construct a line from Philadelphia to West Chester, a distance of 23 miles.

TELEGRAPH AND TELEPHONE.

DECATUR, ILL.—There is some talk of a consolidation between the Citizens' Mutual Telephone Company and the Central Union Telephone Company.

COPEMISH, MICH.—A telephone line has been established between this place and Arcadia by the Arcadia & Betsey River Railroad Company for the purpose of operating the train service on the new road. The telephone is used in place of the telegraph.

CLEBURNE, TEX.—A first class telephone exchange has been secured for this place. Eighty-five instruments, made by the Standard Telephone & Electric Company, Madison, Wis., are now in use and 12 more have been ordered for new subscribers. Mr. J. A. Caldwell is manager of the exchange.

WALWORTH, N. Y.—The Walworth Telephone Company has been organized to build a new line to Walworth Station, 3½ miles in length. The necessary papers have been forwarded for the incorporation of the company under the laws of New York State, the capital stock to be 50 shares at $10 per share. Thirty shares were taken by citizens present at the meeting. Mr. Ernest W. Brown, of Palmyra, will construct the line and furnish the necessary telephones.

THE RICHMOND TELEPHONE COMPANY, Richmond, Va., which recently opened its exchange for service, reports 1100 statjons connected and all the trunk lines completed. It has several hundred subscribers waiting for connection and hopes to have 1500 stations in service by March 1. This exchange, which is notable as being so far the largest constructed in opposition to the Bell Company, has a full metallic circuit system of the most approved modern type of construction.

ELECTRIC LIGHT AND POWER.

TAUNTON, MASS.—At the local election on Dec. 8 the municipal lighting proposition was carried.

PARIS, ILL.—The City Council voted for the purchase of an additional dynamo at the electric light plant.

CLEBURNE, TEX.—The Cleburne Electric Light & Power Company will install a 1000-light alternating-current dynamo.

BLOOMINGTON, IND.—A movement is on foot among several business men to erect a new electric light plant in this city, solely for the purpose of lighting the business districts.

BRUNSWICK, GA.—The Oglethorpe Hotel will be improved and enlarged at a cost of about $10,000. The building will be equipped with an electric light plant. M. S. Gibson is proprietor.

XENIA, O.—A company has been organized in this place for the purpose of supplying electric light and power. In connection with the business, a large ice manufacturing plant will be operated. Hon. John P. Martin is president of the new company.

CAMBRIDGE, O.—The City Council has passed a resolution providing for the building of an electric light plant by the city, to cost not exceeding $18,000. Authority was given for the employment of an engineer to prepare plans for a plant capable of furnishing 100 arc lights and 2000 incandescents.

SCRANTON, PA.—An ordinance has been introduced into the City Council providing for an increase in the city debt to the amount of $200,000 for the purchasing of land, erecting the necessary buildings, and equipping the same with electric lighting apparatus and machinery for the lighting of the city. The funds are to be raised by an issue of city bonds and the question is to be submitted to the voters of the city at the next election which will be held on Feb. 16, 1897.

THE ELECTRIC RAILWAY.

BOSTON, MASS.—The stockholders of the West End Street Railway Company have ratified the lease by that road of the subway now being constructed by the Boston Transit Commission.

McKEESPORT, PA.—It is stated that the next move in McKeesport electric railway building will be the construction of the proposed road from that city to West Newton. The line has been surveyed and the rights of way are now being secured.

NEW HAVEN, CONN.—Leading Woodbridge capitalists will petition the coming Legislature for a new electric line, beginning in Westville and extending through Seymour and Bethany to Naugatuck. It will be about 15 miles in length and cost about $250,000.

CHICAGO, ILL.—The City Council on Dec, 14 passed an ordinance calling for a four-cent fare on all the street car lines in Chicago. The vote was overwhelmingly in favor of the measure. It is stated that the street car companies will fight the matter in the courts.

MUSKEGON, MICH.—The Crosby Transportation Company has filed articles of incorporation for an independent telephone line between Muskegon and Grand Haven, a distance of 12 miles, for the purpose of conducting its boat business with greater facility.

NEW HAVEN, CONN.—A petition for a charter is to be made to the next Legislature for a road from Litchfield to South Norfolk, a distance of 45 miles. S. P. Williams, of Waterbury; W. S. Judd, of Litchfield; John H. Wadhams, of Goshen, and others are interested.

PITTSBURG, PA.—It is stated that plans have been prepared by the North Shore Railway in Pennsylvania for a new electric railway line from the City of Beaver Falls, Pa., to Rochester, Pa., and up the Ohio River to Conway. The estimated cost of the new line is $500,000.

SUFFIELD, CONN.—The Enfield & Longmeadow Electric Railway Company will petition the General Assembly at its next session for an amendment

to its charter to build branch roads to Suffield and Somers. The Suffield branch is to extend to West Suffield and the Massachussetts State line.

MILWAUKEE, WIS.—It is reported that the Milwaukee Electric Railway & Light Company has purchased the plant and franchise of the Pabst Power & Heating Company. The Wauwatosa Electric Railway, it is stated, is included in the deal. The price paid for the entire property is said to have been between $600,000 and $800,000.

NEWTOWN, PA.—There is talk of extending the Langhorne & Bristol Trolley Road to Newtown. The distance between Langhorne and Newtown is four miles, and it is stated that the right of way has been secured with the exception of the consent of the Pennsylvania Railway Company. The opposition from this source may necessitate extraordinary means to complete the project.

THE WHITE RIVER POWER COMPANY has been granted a charter by the Vermont Legislature for the generation and sale of power, light and heat in the counties of Windsor, Vt., and Grafton, N. H. The power is located at Centreville, Vt., and the office of the company is at White River Junction, Vt. The capital stock is not to exceed $100,000. The names of the incorporators are A. F. Watron, Amos Barnes, W. P. Burton, Frank Callins, D. A. Parrin, George H. Fuller and F. H. O'Neill.

BROOKLYN, N. Y.—On the evening of Dec. 15, through the failure of the current supply, the new electric motor cars on the Brooklyn Bridge were stalled. The current is supplied temporarily from the Kent Avenue power station of the Brooklyn Heights Railroad Company, and owing to the breaking of the cross head of one of the large engines, the station was crippled, and the Bridge current greatly diminished. The retired steam locomotives were hurriedly fired up and pressed into service.

HARTFORD, CONN.—A contract was signed on Dec. 15 for the construction of an electric power house, at Berlin, Conn., which it is stated will be the largest plant of its kind in the country. The station will supply current to the Berlin and Middletown branches of the New York, New Haven & Hartford Railroad Company and the New England lines from New Britain to Hartford. It will also operate the electric system in Meriden and light all the railway stations, including that at Hartford. The new plant will be equipped with the best and most modern apparatus.

Legal Notes.

CARBORUNDUM PATENT.—The Pittsburg papers announce the beginning of an infringement suit in the United States District Court, involving the ownership of the carborundum patent. The suit alleges infringement of the patent on the Cowles electric furnace and was brought by the Cowles Electric Smelting & Aluminum Company, of Lockport, N. Y, against the Carborundum Company of Niagara Falls.

BROOKLYN, N. Y.—The Appellate Division of the Supreme Court has rendered a decision upholding the validity of the trolley speed ordinance adopted by the Brooklyn Board of Aldermen a couple of years ago. This decision was rendered in a test case. The ordinance provides for the running of trolley cars at various rates of speed within the city limits. The case, it is stated, will probably be carried to the Court of Appeals.

Obituary Notes.

MR. DAVID L. BARNES, who was consulting engineer of the Baldwin-Westinghouse combination in the building of electric locomotives, died in New York City on Dec. 15. Mr. Barnes was born in Providence, R. I., on Aug. 23, 1858, and was graduated from Brown University. He was a member of various engineering societies, and was for eight years one of the editorial staff of *The Railroad Gazette*. His principal office was in Chicago.

MR. HARVEY L. LUFKIN, manager of the Crocker-Wheeler Electric Company, died at Mt. Sinai Hospital, New York City, on the morning of Dec. 21, as a result of an operation for appendicitis. Mr. Lufkin had a large circle of friends in the electrical fraternity, all of whom will be profoundly shocked at the announcement of his sudden and untimely death. He was born in Cleveland, Ohio, in 1857, and was therefore 39 years of age. Mr. Lufkin was one of the early workers in the electrical field, having been engaged in it since 1886. He recently returned from a trip to the Pacific Coast.

Personal Note.

MR. E. H. JOHNSON, president of the Interior Conduit & Insulation Company, New York, has returned from Europe much pleased with the results of his trip. He and his family will spend the Winter at the Hotel Savoy, New York.

Trade and Industrial Notes.

ST. LOUIS, MO.—The Wagner Electric Manufacturing Company has increased its capital stock from $100,000 to $250,000.

DE VEAU & CO., 32 and 34 Frankfort Street, New York, have just issued the seventh edition of their catalogue of telephones and telephone and electrical supplies. It is of pocket size, but complete.

MR. H. N. RANSOM, representing the electrical department of the Consolidated Car Heating Company, Albany, N. Y., will hereafter make his headquarters at 136 Liberty Street, New York City.

THE METROPOLITAN ELECTRIC COMPANY, Chicago, reports a large demand for Perkins' switches and sockets, of which it carries a large stock. These switches are neat, well-built, and give general satisfaction.

FOREIGN OFFICES OPENED.—The Westinghouse Electric & Manufacturing Company, it is stated, has opened branch offices in Japan, the Argentine Republic, Chili and Mexico. Its foreign business is steadily increasing.

THE WESTERN ELECTRIC COMPANY, of Chicago, has been given the agency for the complete line of Lundell power motors. These motors will be kept in stock in Chicago subject to immediate delivery, and prices and full information will be given upon application.

THE SHELBY ELECTRIC COMPANY, Shelby, O., is now standardizing its factory with the intention of shortly entering the lamp business. It will use the Chaillet system of lamp making, and expects to put upon the market a uniform and superior quality of incandescent lamps.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., the well-known manufacturer of graphite productions, has issued a very complete catalogue of its goods. These include graphite lubricants of all kinds, graphite paints, crucibles, belt-driving and leather preservatives, and lead pencils in great variety. On the front cover are colored views of the Jersey City works, the graphite mills and mines, and the cedar mills in Florida, where the cedar wood is prepared for pencils.

ELECTRIC LAUNCHES.—The Electric Launch Company, Morris Heights, New York City, has issued a very handsomely illustrated catalogue of its electric launches and electric passenger boats for service on the waters of public parks and pleasure resorts. A detailed description of these boats is given, together with illustrations of the mechanical and electrical apparatus. The World's Fair electric launch service forms an interesting feature of the descriptive matter, and the accompanying illustrations are excellent.

CALENDARS.—The Missouri Telephone Manufacturing Company, 917-919 Market Street, St. Louis, has issued a handsomely colored wall-calendar for 1897. The picture is that of a little girl standing on a chair, holding to her ear a telephone receiver a telephone set hanging close by on the wall.

The Ashton Valve Company, 271 Franklin Street, Boston, is presenting the trade with a neat monthly calendar for the new year. It is designed to hang up on the wall, and is embellished with a very artistic picture on the upper half of the card.

ELECTRIC RAILWAY CONTRACTS.—The Hyde Park Street Railway Company, Hyde Park, Mass., is erecting a new power station. The boiler room is 44 feet wide and 87 feet long, and the engine room is 56 feet wide and 115 feet long. The building is to have brick walls and the roof is to be supported by steel trusses. The steel work has been designed and will be furnished and erected by the Berlin Iron Bridge Company, of East Berlin, Conn. The latter company has received the contract from Stone & Webster, engineers, Boston, Mass, for the steel work in the power plant for the Brockton Street Railway Company, Brockton, Mass.

ELECTRA CARBONS.—Manufacturers of enclosed arc lamps are rapidly coming to the conclusion that the Electra high grade Nuernberg carbon is one of the best for enclosed arc lamps, and many of them are recommending and urging the use of these carbons with their lamps. So great has been the demand for Electra carbons for enclosed arc lamps that, according to the statement of the Electric Appliance Company, Chicago, it has been impossible during the past few months to import them fast enough. The Electrical Appliance Company reports a splendid business in these goods, and states that all of its customers are more than pleased with them.

THE MISSOURI TELEPHONE MANUFACTURING COMPANY, St. Louis, Mo., is at present building equipments for 10 exchanges, located at various points throughout the United States. It is preparing to install its own engine, and will furnish its own power. This company has now in press what it claims to be the largest and most complete telephone catalogue ever issued, and it will be pleased to send a copy to any one, on application. It will be issued about Jan. 1, 1897. It has also issued 10,000 calendars, which are given away gratis. The company manufactures 12 different styles of microphones, 25 styles of instruments and four styles of switchboards.

THE JEFFREY MANUFACTURING COMPANY, Columbus, O., requests us to state that the recent decision of Judge Sage in regard to mining apparatus affects only a small piece of metal that was formerly used on the front end of the Jeffrey Company's machine, and which may be entirely removed with advantage to the machine. It adds that Judge Sage has suspended the injunction pending an appeal to the Circuit Court of Appeals, which will review the case about February next, and that the Jeffrey Company has given a bond which fully protects customers during such interim in the use of machines manufactured by it. It says it will also defend and hold customers harmless in any suits that may be brought against them in connection with the use of its machines hereafter, regardless of the outcome of this litigation. The Jeffrey Manufacturing Company was incorporated in 1877, and has a paid-up capital and surplus of $540,000. Its plant is said to be the largest and best equipped of its kind in the world.

THE HOPPES MANUFACTURING COMPANY, Springfield, O., manufacturer of feed-water purifiers and heaters has, we are informed, recently received some very gratifying orders, among which are the following: John Morrell & Co., Ltd., duplicate order for 500-hp purifier; also 350-hp exhaust heater, Ottumwa, O.; Alcatraz Asphalt Company, Carpenteria, Cal., 100-hp purifier; St. Augustine (Fla.) Gas & Electric Light Company, Ltd., 60-hp purifier; Louisville (Ky) Railway Company, duplicate order for 125-hp purifier; Liggett & Myers Tobacco Company, St. Louis, Mo., three 2250-hp purifiers; Northern Grain Company, Manitowoc, Wis., 200-hp purifier; Brooklyn (N. Y.) Hygienic Ice Company, 500-hp purifier; South Dakota Hospital for Insane, Yankton, S. D., 80-hp purifier; Dayton Malleable Iron Company, Dayton, O., 200-hp purifier Chattanooga (Tenn.) Lithograph & Printing Company, 500-hp purifier; Peoria (Ill.) Water Company, 500 hp purifier; Indianapolis (Ind) Hospital, 200-hp heater; Milwaukee Sander Manufacturing Company, Green Bay, Wis., 75-hp heater; Rowland Hazard, Mine la Motte, Mo., 100-hp heater; Kupferle Bros., Manufacturing Company, St. Louis, Mo., 200-hp heater; Village of Clayton, Ill., 75-hp heater; Chas. G. Stifel, St. Louis, Mo., 150-hp heater; St. Louis Iron & Machinery Company, St. Louis, Mo., 75-hp heater; Rochester (Minn.) State Hospital, 400-hp heater; Kansas State Insane Asylum, Ossawatomie, Kan., 150-hp heater; P. H. & F. M. Root Company, Connersville, Ind, 100-hp heater; H. Guenther & Bros., Owensboro, Ky., 100-hp heater; Acme White Lead and Color Works, Detroit, Mich., 200-hp heater; California (Mo.) Electric Light & Power Company, 100-hp heater; Springfield, (O.) Silver Plate Company, 75-hp heater; Alex. Balfour (repeat order), Pencoyd, Pa., 300-hp heater.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York City.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

ENGINEERS.—I will send a check of 50 cents, made payable to the engineer that will send me his full name and house address, with the name and business address of the firm he is employed by. Address, Publisher, 158 North Third Street, Philadelphia.

EVERYDAY EXCURSIONS to all parts of the world can be arranged for any day in the year, for one or more persons, upon application to any principal ticket agent of the Chicago, Milwaukee & St. Paul Railway. Itineraries carefully prepared for excursions to California, Florida, Mexico, China, Japan and to any part of Europe. Estimates furnished, including all expenses. Tickets furnished for the complete journey. It is not necessary to wait for any so-called "Personally Conducted Excursions" In these days of progressive enlightenment, with the English language spoken in every land under the sun, one does not need to depend upon the services of guides for sight-seeing but can go it alone or in small family parties, with great comfort and security and at one's own convenience. Write to E. F. Richardson, General Agent Passenger Department, Chicago, Milwaukee & St. Paul Railway, New York City, for details if you are contemplating a trip.

Illustrated Record of Electrical Patents.

572,945. MECHANICAL TELEGRAPH SOUNDER; W. W. Alexander, Kansas City, Mo., and M. C. Gillham, Kansas City, Kan. App. filed April 23, 1894. A mechanical telegraph signaling instrument, consisting of an electromagnet, its armature, an oscillating lever connected therewith, a retractile spring attached to said lever, adjustable stops on opposite side of said lever, a pivot-shaft for said lever, hooked arms secured to said shaft and a pivoted arm to engage with said arms, pallets and a crank upon a pivot-shaft of the arm, a springy connecting rod uniting said crank with a pivoted sounder lever, two other pivoted arms to engage alternately with the pallets on the shaft, a coiled spring mounted upon the pivot-shaft of the arms and having one end connected to a pinion with means to rotate said pinion.

572,981. RESONATOR FOR PIANOS; F. L. Goulvin, Valence, France. App. filed April 30, 1894. A device consisting in the combination with the casing provided with supporting feet and having an offset, of a bridge-piece integral with the casing, a rod screwed to said bridge-piece, a bobbin upon said rod, another bridge-piece, a diaphragm resting upon the shoulder or offset, and a wooden disc arranged over the diaphragm and provided with an orifice.

573,009. DIRECT-CURRENT DYNAMO-ELECTRIC GENERATOR; B. G. Lamme, Pittsburg, Pa. App. filed March 11, 1896. A parallel-wound armature for multipolar direct-current machine provided with alternating-current connections between points in its winding of normally equal potential, through which leading and lagging currents may be transmitted to equalize the magnetic circuits of the machine.

573,021. ELECTRIC METER; W. D Marks, Philadelphia, Pa. App. filed Oct. 20, 1896. In an electric meter, the combination with a controlling ampere-meter, and means for automatically tapping the ampere-meter.

573,033. ELECTRIC RAILWAY SYSTEM; B. E. Osborn. Auburn, N. Y. App. filed April 10, 1896. In an electric railway system the combination of a moving vehicle, a concealed conductor for the passage of the main current, a conductor for conveying the main current to the vehicle, independently-movable connecting-pieces for connecting said conductors, electromagnets for operating the connecting-pieces, additional electromagnets for governing the operation of the former electromagnets, and means carried by the vehicle for controlling the operation of the additional electromagnets.

573,042. ELECTRIC BOILING APPARATUS; F. W. Schindler-Jenny, Kennelbach, Austria-Hungary. App. filed Feb. 27, 1894. An electric boiler comprising a hollow ring or annular water-tight body, a base of insulating material therein, one or more electric conductors secured to said base, a handle and a brace connecting said handle and annular body, the electric conductors passing through said brace and handle.

573,066. ELECTRIC RAILWAY CONSTRUCTION; G. Westinghouse, Pittsburg, Pa. App. filed June 8, 1896. A structure for surface-contact electric railways, comprising a switch-box, a beam provided with contact-supporting devices and extending laterally from said switch-box beneath both track-rails, and means for clamping both the switch-box and the beam to the track rails.

573,078. WATTMETER; T. Duncan, Fort Wayne, Ia. App. filed April 29, 1896. The combination with the armature, of a field due to and varying with the current in amperes flowing in the series coil, an asynphased field representing the E. M. F. in volts, and varying directly as the pressure and means for inducing an independent torque between said voltage field and armature.

573,079. METER FOR MEASURING ELECTRIC CURRENTS; T. Duncan, Fort Wayne, Ind. App. filed May 7, 1896. In a drag or brake, the combination with radially disposed magnets, one or more, of a paramagnetic ring embracing their poles and in close proximity thereto, and means for inducing relative motion between said ring and magnets in the plane of the latter.

573,080. ELECTRIC METER; T. Duncan, Fort Wayne, Ind. App. filed July 22, 1896. A disc armature comprising a plurality of sector or segment-wound coils lying flatwise in the disc with their arcs toward the periphery thereof, in combination with sector or segment-wound series-coils laid parallel with the plane of the disc with their arcs overlying the arcs of the armature coils.

573,082. ELECTRIC METER; C. Erben, Berlin, Germany. App. filed Oct. 10, 1895. In an electric meter, the combination with the oscillatory balance spiral spring of a clockwork, of an arm secured to said spiral spring, movable abutments for said arm, and magnets adapted to be influenced by the current to be measured for the movement of said abutments into such position that they limit the free space for the oscillation of the said balance-spring.

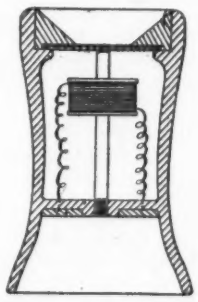
573,088. ELECTRIC SIGN; F. H. Hawkins, New York, N. Y. App. filed Jan. 13, 1896. A luminous sign comprising a vacuum chamber having a transparent face and also having a back wall and a partition wall between the back wall and face, a filament or plurality of filaments of carbon or other suitable material arranged in said chamber between the partition wall and face thereof and shaped to form a letter, figure or symbol, and conductors arranged between the partition and back walls and connected to the filaments and adapted to be electrically connected with an electrical generator.

573,092. INSULATOR; F. M. Locke, Victor, N. Y. App. filed Aug. 24, 1896. An insulator comprising two members, one consisting of insulating material having high surface resistance, but puncturable by electricity, as porcelain, and the other consisting of insulating material having high resistance against puncture, and low surface resistance applied to the former opposite to the points thereof most liable to puncture.

573,101. WALL INSULATOR; J. J. O'Neill, Boston, Mass. App. filed Dec. 19, 1895. An electric insulator consisting of a tapering member provided with a lug forming a stop, and a curved or hooked insulator member extending from the tapering member intermediate of its ends.

573,105. COLLECTING BRUSH; E. B. Raymond, Schenectady, N. Y. App. filed Aug. 5, 1896. As a new article of manufacture, a collecting brush for a dynamo-electric machine, composed of a core of conducting material and a layer of insulating material upon the outside of the core.

573,107. SECURING FIELD MAGNET POLES; H. G. Reist, Schenectady, N. Y. App. filed Aug. 24, 1896. The combination with a revolving field magnet structure, of pole-pieces separated from each other and arranged on the periphery of said field magnet structure, said pole-piece being composed of laminated material and being dove-tailed into the periphery of said revolving structure, and means for taking up the play of the parts.



NO. 572,981.—RESONATOR FOR PIANOS.

573,117. TELEPHONE CIRCUIT LINE SIGNAL; T. C. Wales, Jr., and C. H. Arnold, Boston, Mass. App. filed July 20, 1896. A telephone circuit provided with a call signal, a signaling current generator furnishing current therefor, a secondary line signal in a local circuit, and a polarized electromagnetic device in inductive relation with the circuit of said generator controlling the said secondary signal.

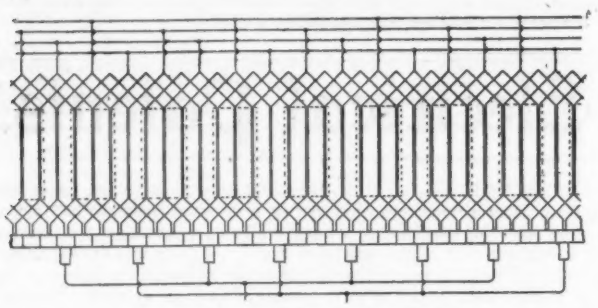
573,130. ATTACHING FIELD MAGNET POLES; F. O. Blackwell, Schenectady, N. Y. App. filed Aug. 24, 1896. The combination with a revoluble field magnet structure, of laminated pole-pieces separated from each other and arranged and located in sockets on the periphery of said revoluble structure, registering notches in the lower end of said pole-pieces in said sockets and keys located in said registering notches securing the pole-pieces to the periphery of said revoluble structure.

573,134. THERMOSTAT; C. Burgher, Newton, Mass. App. filed Aug. 8, 1896. In a thermostatic instrument, the combination with a shell or casing provided with a recticulated or foraminous bottom, having a plurality of holes or openings and provided at its opposite end with a spider or open frame having a raised centre portion and a cap or cover attached to and supported above the said casing or shell by the said raised centre portion of the said spider to leave an air space or passage, and active members secured within the said casing or shell.

573,142. METHOD OF AND MEANS FOR REMOVING PARAFFIN FROM OIL WELLS; F. A. Flanegin, Washington, D. C. App. filed April 7, 1896. The method of removing paraffin from oil wells, which consists in heating a paraffin solvent, circulating the solvent in the well and its crevices, thereby dissolving the paraffin by contact with the hot solvent and removing the solvent and contained paraffin from the well.

573,146. SWITCH; E. M. Hewlett, Schenectady, N. Y. App. filed July 16, 1896. In an electric switch, the combination of a stationary electrode, a movable electrode, a blow-out magnet provided with a movable pole-piece, and an armature adapted to actuate the movable electrode and the pole-piece.

573,161. ELECTRIC ARC LAMP; C. Richter and R. T. Eshler, Camden, N. J. App. filed March 26, 1896. An electric arc lamp, having a chamber with a cap for holding a positive carbon, and a conical-shaped open lower end, a cup with means for holding the negative carbon, and a spring which is connected with said cup and supports said chamber, said spring embracing a neck on said chamber, and said parts being combined.



No. 573,009.—Direct Current Dynamo Electric Generator.

573,162. ELECTRIC ARC LAMP; C Richter and R. T. Eshler, Camden, N. J. App. filed April 9, 1896. An arc lamp having a solenoid with an armature, guide-rods for said armature connected with the body of said solenoid, a stop on said rod for said armature, an air-pump on said solenoid having a plunger connected by links with said armature, said parts being combined.

573,169. ELECTRIC RAILWAY; A. Sprague, San Leandro, Cal. App. filed March 30, 1896. In an electric railway a channeled insulated surface rail having a conductor fixed to it, a pivotally secured lever having a trolley to engage the conductor, a lever by which the trolley lever is carried, and a slide connected with the latter lever and adapted to move the trolley into and out of contact with the conductor.

573,176. ELECTRIC CABLE; F. Borel, Cortaillod, Switzerland. App. filed Jan. 7, 1896. An improvement in electric cables consisting in a conductor of copper, an enclosing tube of copper, and intervening asbestos forming the insulating material, such asbestos not being injured by heat and not injuring the conductor in the rolling or drawing operations.

573,207. INDICATOR OR SIGNAL; J. P. Coleman, Swissvale, Pa. App. filed June 29, 1896. In an indicator or signal the combination of a case or shell, one or more supporting rods or bars having one end secured in the case or shell, one or more sleeves adapted to fit over said bars, and signal operating mechanism supported by said sleeves.

573,221. ELECTRIC SIGNALING APPARATUS; F. B. Herzog and S. S. Wheeler, New York, N. Y. App. filed Jan. 25, 1886. The combination in a signal-transmitting instrument of two or more separately variable transmitting mechanisms, each including a motor, together with shifting devices.

573,222. AUTOMATIC GROUNDING DEVICE FOR ELECTRIC CONDUCTORS; G. A. Jewett, Chicago, Ill. App. filed Dec. 6, 1895. The combination with a suspended main conductor and its supports, of a contact device embracing stationary and movable parts, through which said conductor may be connected with the ground, and an open-bottomed hood surrounding both parts of the contact device, said hood and movable part of the contact device being attached to the conductor at a distance from its supports, and the movable part of the contact device being supported by the conductor above the stationary part thereof and in position to be engaged by the same in its descent, the parts being so arranged that the hood will act as a weight to aid in bringing the movable part of the contact device into engagement with the stationary part thereof, and also as a means for holding the parts of the contact device in operative relation.

573,234. ELECTRIC RAILWAY; A. C. O'Connor, Lynn, Mass. App. filed Oct. 26, 1895. In an electric railway system, the combination of positive and negative wires arranged over a track, rods extending across the track for supporting the wires, arms mounted to swing on said rods, but insulated therefrom, roller contacts on the free ends of said arms, permanent electrical connections between the rods and wires, forked standards mounted on the car, bars supported on said standards, but insulated therefrom, and connections between the bars and a motor on the car.

573,245. ELECTRIC SOLDERING CLUB; P. Stotz, Stuttgart, Germany, and F. W. Schindler-Jenny, Kennelbach, Austria-Hungary. App. filed Jan. 14, 1895. An electrically-heated soldering iron, consisting of the casing, an insulating heat body containing within said casing a conducting-wire located in said heat body, a soldering member or head separable from the casing, said casing and head fitting one partially within the other and sliding one upon the other, a clamp carried by said iron and connected to said head so as to be detached therefrom, and means for drawing said clamp longitudinally to effect close contact between the meeting surfaces of the casing and head.

573,257. TROLLEY-POLE SAFETY DEVICE; B. H. Borreson, Minneapolis, Minn. App. filed Jan. 26, 1895. The combination with a trolley-pole of a tension device therefor having a base or anchor part, which is movable with respect to the trolley-pole, and a combined trip and setting device for said movable base or anchor part comprising a pair of levers that are locked to set said tension device under strain by engagement with each other at a point to one side of the dead centre of said levers, and are tripped by the direct contact therewith of parts that are rigid with the trolley-pole.

573,286. RECEIVER FOR SUBMARINE TELEGRAPHS; A. Piedfort, Paris, France. App. filed Dec. 19, 1895. In a receiver for submarine telegraphs, the combination with a galvanometer, of a mechanical multiplier comprising a rotating barrel, chains wound about said barrel, said chains being connected at one end to the galvanometer-coil directly or indirectly, and at the other end to the operating-lever at opposite sides of its pivot or fulcrum and at equal distances therefrom and the said operating-lever, whereby the connectors wrapped about the barrel will be constantly drawn toward the coil of the galvanometer in such a manner that the part of each connector which is attached to said coil may be always floating, so as not to produce displacement of the coil about the vertical plane of its support.

573,294. TELEPHONE TRANSMITTER; F. A. Ray, Boston, Mass. App. filed April 6, 1896. In a telephone, a diaphragm composed of two parts, a stationary member, and an active member for vibratory movement non-contiguous to the stationary member, the periphery or edge of said active member being unconfined except at requisite points for attachment to the stationary member.

573,302. CONDUCTOR OF ELECTRICITY AND CONDUIT FOR HOLDING SAME; A. Selkirk, Albany, N. Y. App. filed Jan. 30, 1896. In an electric conduit, the combination of two metallic rail-form side pieces of equal length and having each a horizontal base portion which is joined with the other, a water-resisting packing between the said joined portions of said side pieces, an end-closing piece at each terminal of such joined rail-form side pieces and secured between the same and having in them longitudinal perforations which are adapted to permit the passage of terminal portions of electrical conductors from within to without said conduit, and a water-resisting packing between the edges of said end closing pieces and the portions of the said rail-form side pieces, of a series of metal sections closing the longitudinal opening between the unjoined edge margins of the said two rail-form side pieces and adapted to receive on their exterior sides electric conductors for connection with the working conductor contained within the conduit, water-resisting packing between the abutting ends of said metal sections and between the edges of the same and the portions of said rail-form side pieces at which the edges of said sections join, and devices adapted to force the surfaces of the joined portions of the respective pieces toward each other and tightly against the water-resisting packing between.

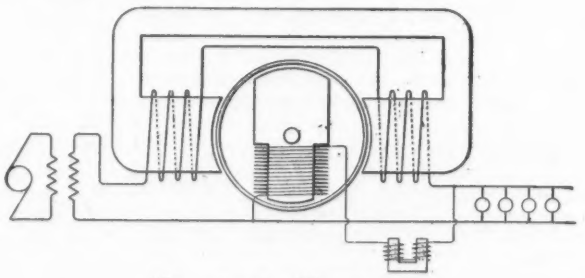
573,350. STATION INDICATOR FOR RAILWAYS; A. Palfy, Budapest, Austria-Hungary. App. filed Aug. 3, 1896. In a station indicator, the combination with a revolving disc carrying an indicating plate of ratchet teeth upon the periphery of said disc, a spring to rotate the disc in one direction, a pawl mechanism to hold said disc against rotation, an electromagnet to actuate said pawl to permit a movement of the disc, an electric bell, a shunt circuit connecting said bell with the circuit which actuates said electromagnet, a secondary shunt circuit leading to the terminals, adapted to be placed in contact with a conducting surface on said disc, whereby said secondary shunt circuit may be completed at intervals through said conducting surface, and a switch adapted to contact with a conductor in either of said shunt circuits, whereby the bell may be actuated through either shunt circuit as desired.

573,356. TELEPHONE TRANSMITTER; L. W. Pullen, Camden, N. J. App. filed Nov. 11, 1895. In a telephone transmitter, the combination of the electrodes, conducting material and insulating ring, arranged parallel with and between the electrodes.

573,386. WIRE JOINT; C. E. Brown, Chicago, Ill. App. filed Oct. 11, 1895. A joint for connecting wires to convey electrical currents, consisting of a sheet of metal foil conversely spirally rolled, so that when twisted with wires inserted therein it will inversely tighten, spreading out at the ends, exhausting the air from the connector and not bulging as a tube or tubes when twisted in a similar manner.

573,387. COMBINATION GAS AND ELECTRIC FIXTURE; J. E. and W. M. Brown, Toledo, O. App. filed July 20, 1896. In a combination gas and electric fixture, a service-pipe, a fixture suspended and supported by means of the service pipe, and an insulated coupling interposed.

573,398. ELECTRIC ARC LAMP; A. C. Dobrick, Chicago, Ill. App. filed June 13, 1896. In an electric arc lamp clutch, the combination with the clutch-rod, of the clutch-collar, a pair of spaced convergently-disposed bearing wires or pins fitted within the collar at opposite points, and the clutch-lever having a clutch-face disposed opposite the convergently-disposed bearing wires or pins.



No. 573,078.—Wattmeter.

573,430. SELF-WINDING MECHANISM FOR ELECTRIC CLOCKS; C. M. Crook, Elgin, Ill. App. filed April 20, 1896. In combination with a self-winding shaft, drum or barrel, two contact-pieces rigid therewith, one insulated and the other uninsulated, the insulated piece having a boss oblique to the axis, the winding magnet and the circuit through which it is energized, comprising the uninsulated contact-piece, and a spring-arm having a finger adapted to bear upon said contact-pieces and standing in the path of rotation of the oblique boss, the arm being adapted to be sprung aside by the oblique boss to allow the latter, rotating in either direction, to pass the finger, whereby the contact of the finger is shifted from one of said contact-pieces to the other.

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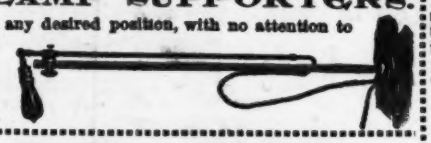
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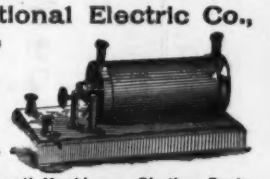
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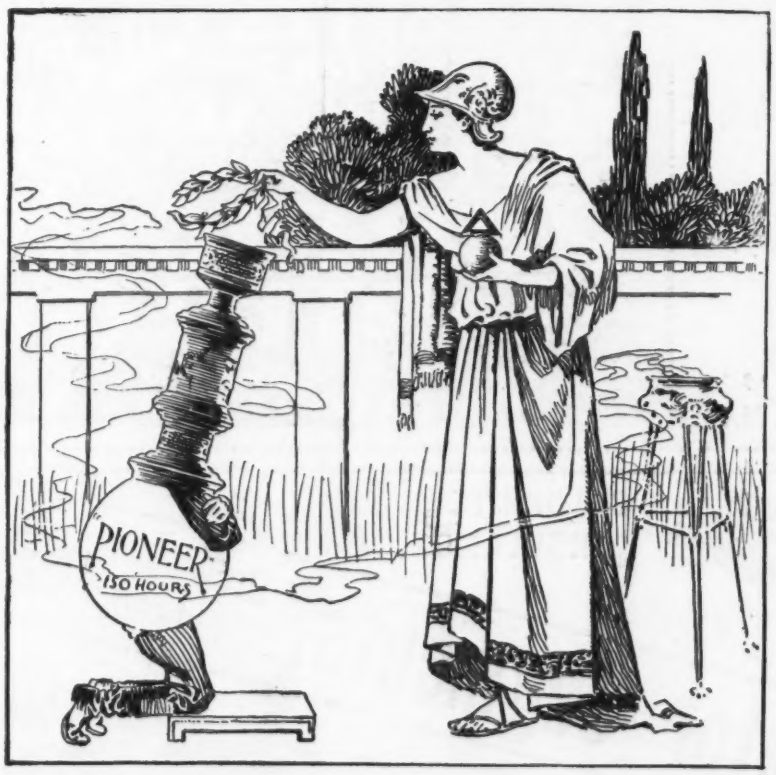

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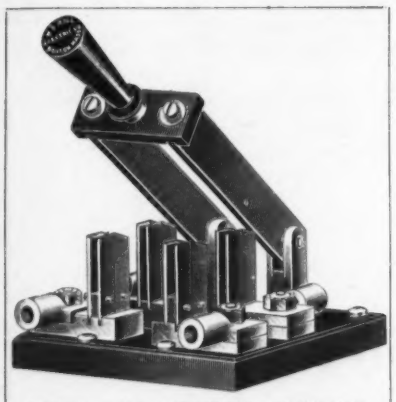

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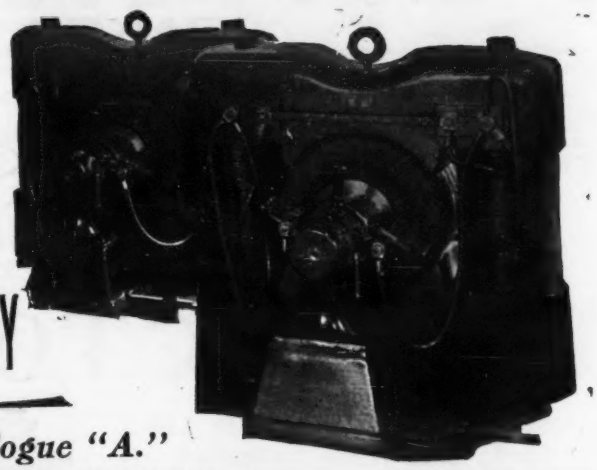

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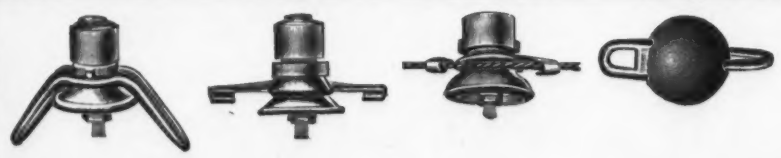

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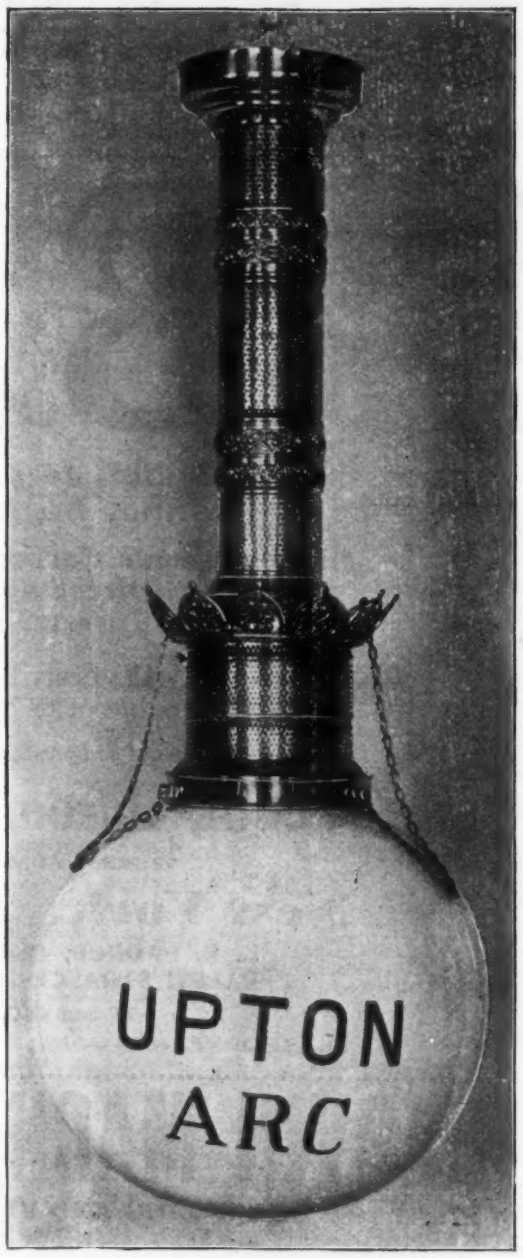

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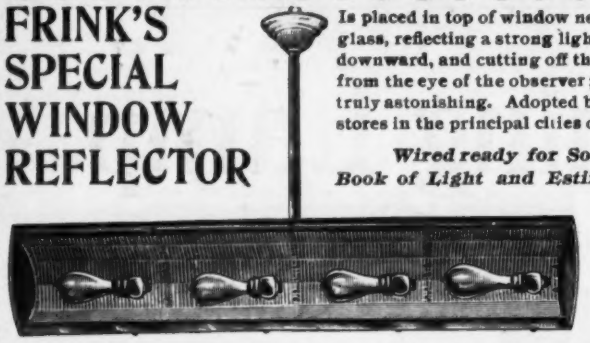

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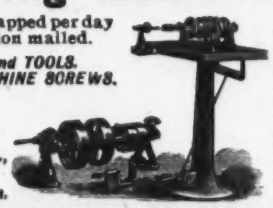

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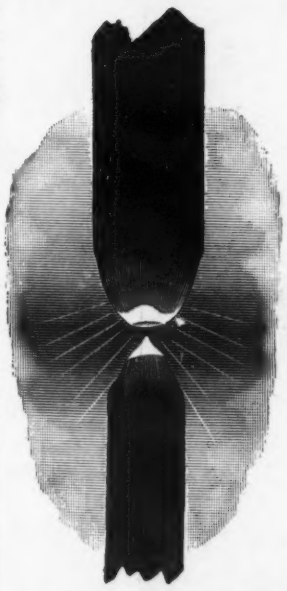

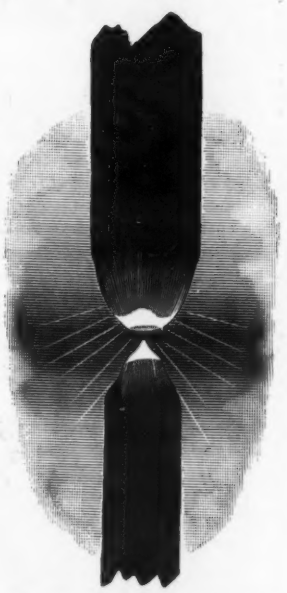

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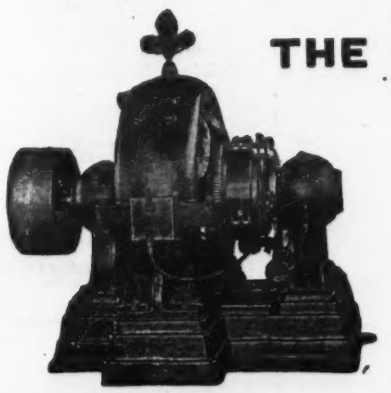

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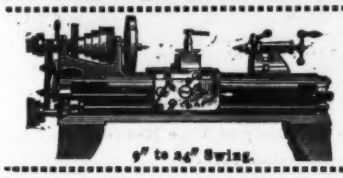

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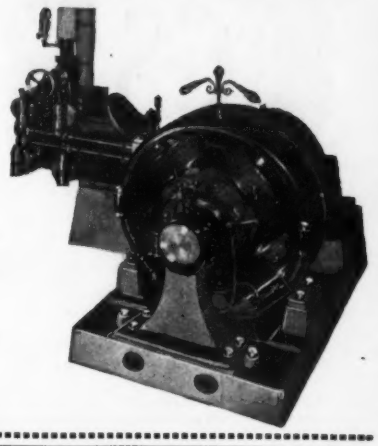

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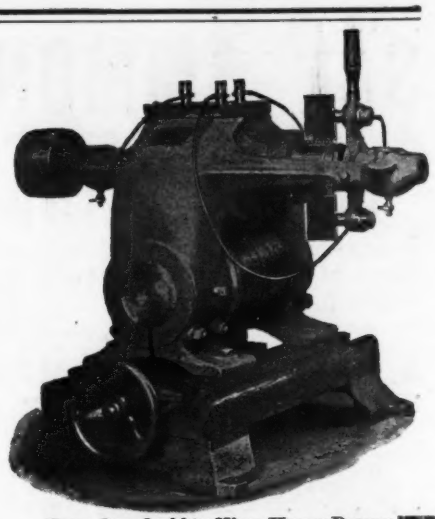

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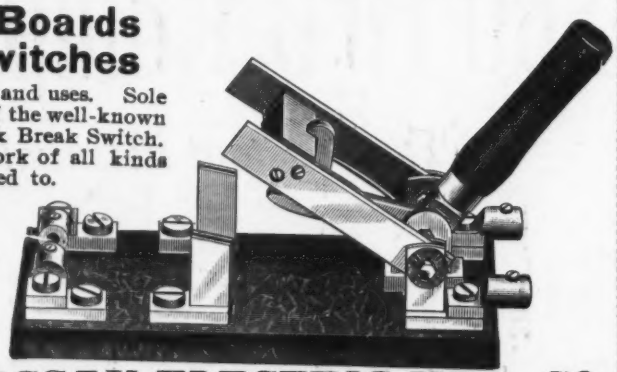

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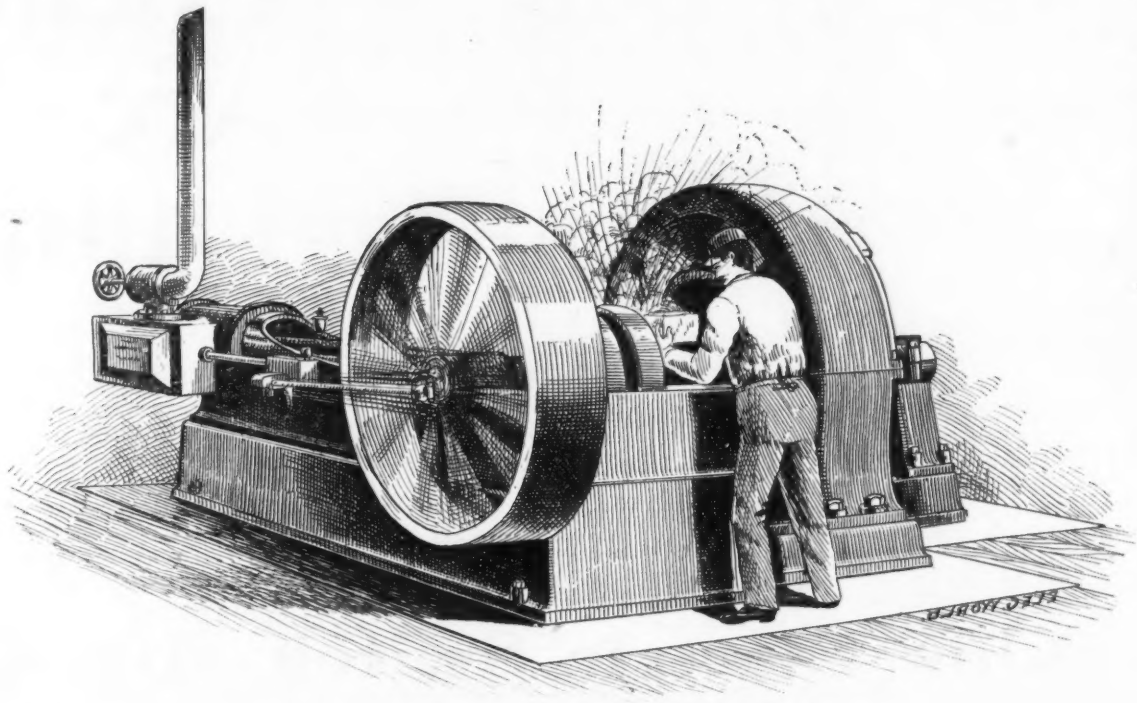

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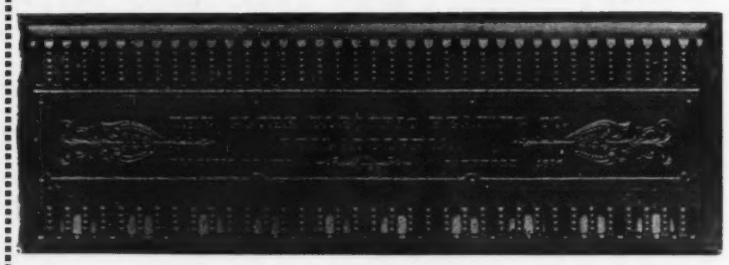

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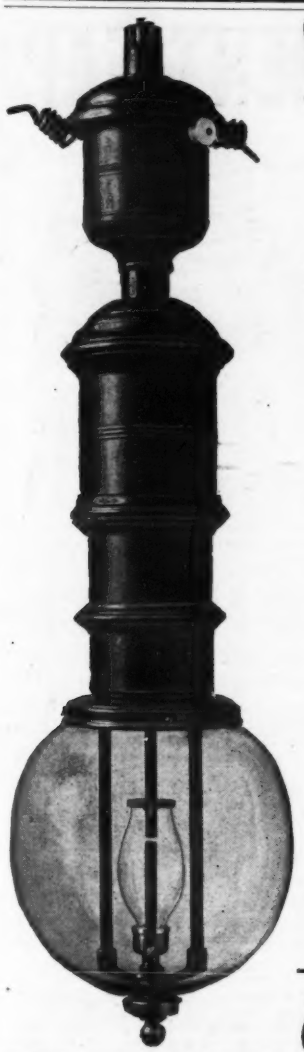

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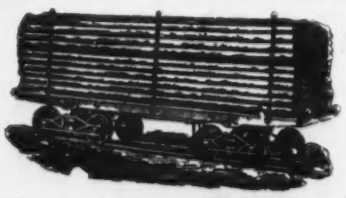

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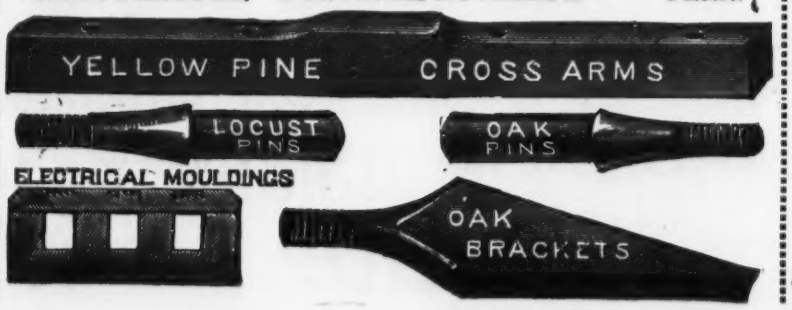

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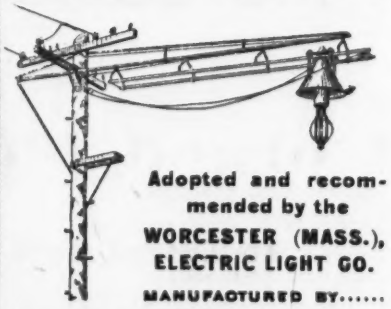

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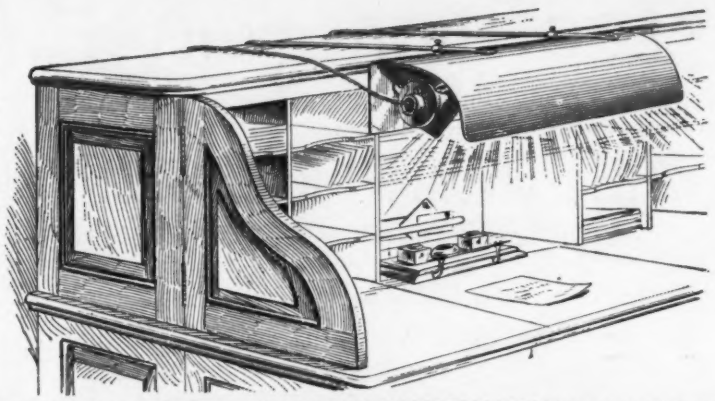

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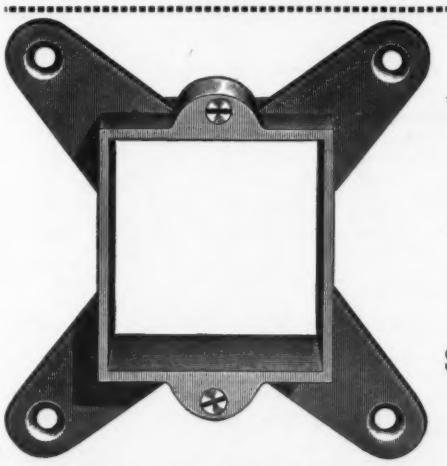

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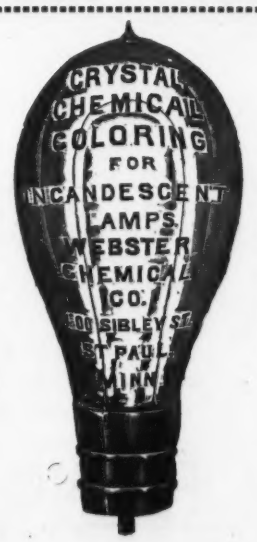

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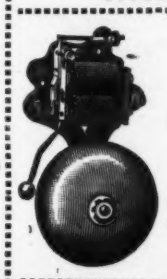

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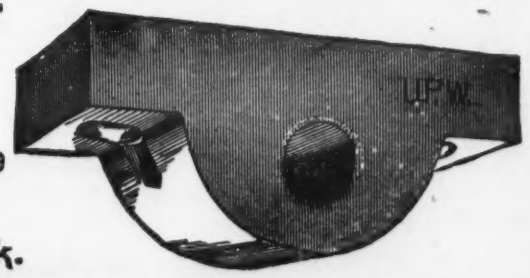

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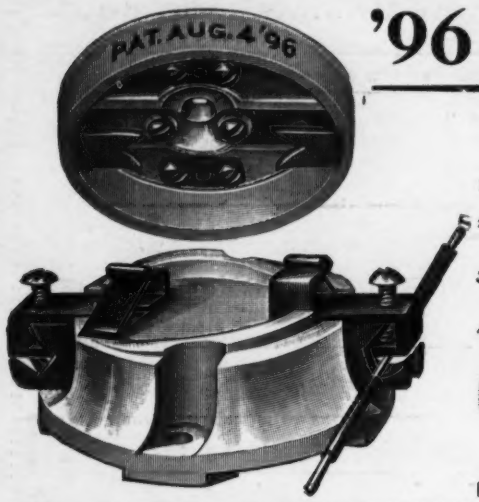

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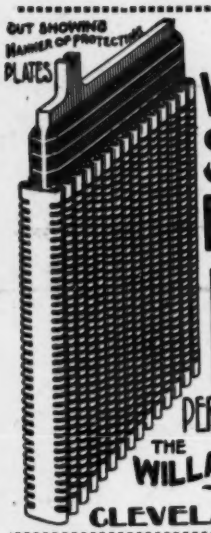

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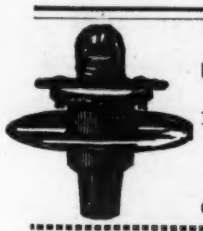

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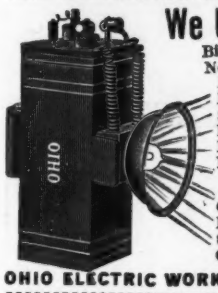

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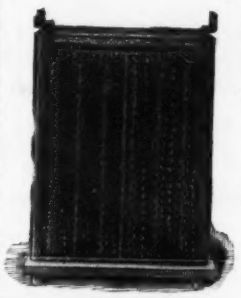

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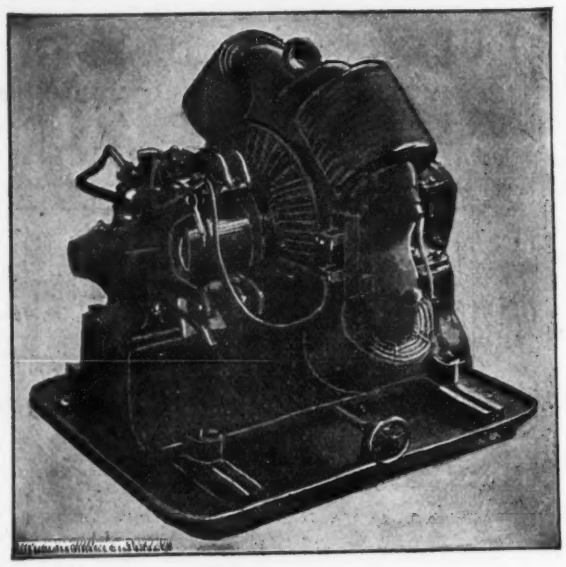

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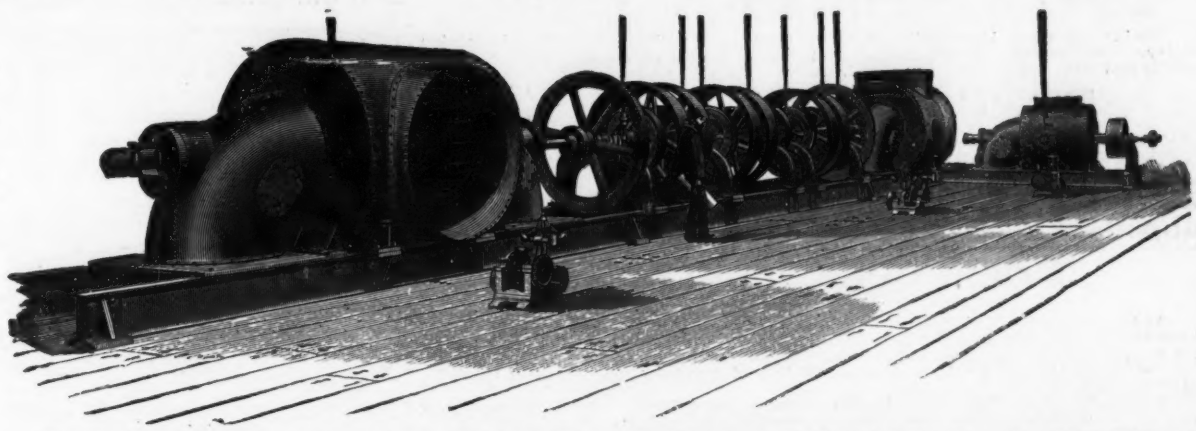

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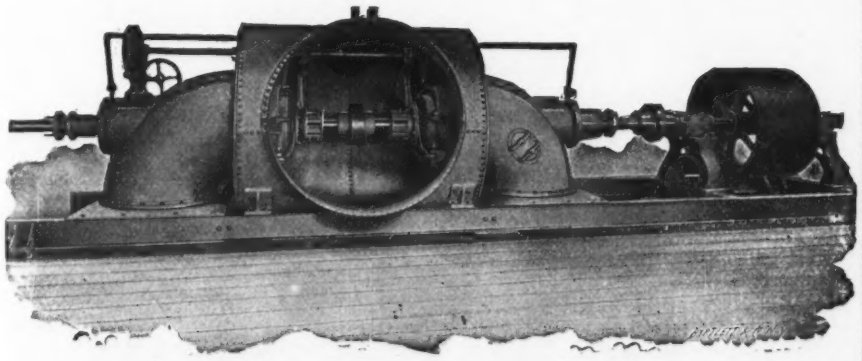

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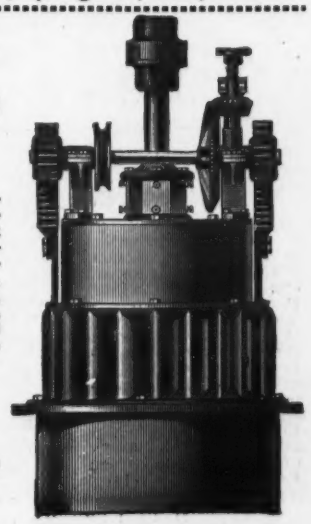

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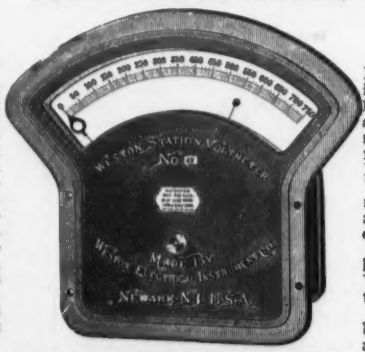

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"I find Gale's does very good work."
UNION DEPOT RAILROAD CO.,
St. Louis, Mo. H. F. PABISH.

"Your Gale's Commutator Compound does very good service."
SANTA FE GAS AND ELECTRIC CO.,
Santa Fe, N. M. E. R. DOWNIE.

Ask your Supply House for "GALES" and take no other.

K. McLENNAN & CO., Sole Manufacturers,
Marquette Building, - CHICAGO, ILL.

Leclanche Battery Jars.

$3.50 per 100.

We offer *during the month of December only,* our Extra Double Strength Round Leclanche Battery Jars at $3.50 per 100, *cash with order.* These Jars are full weight, paraffined and packed in neat boxes, holding 50 jars each.

The Westinghouse Glass Factory

PITTSBURGH, PA.

SITUATIONS WANTED.

ACCOUNTANT OR MANAGER—Young man, 30, now head accountant and assistant manager with large Electric Railway and Electric Light System, desires to change. Competent accountant, wide experience, hard worker, systematic, high executive ability. Thoroughly experienced in accounting, purchasing supplies, daily operating routine and management large railway and light properties. Satisfactory reasons and highest references. Address "BUSINESS," care The Electrical World, N. Y.

HELP WANTED.

The rate for "Help Wanted" advertisements of forty words or less is one dollar and fifty cents an insertion; additional words three cents each. Remittance should accompany order.

WANTED.—By leading firm, a first-class traveling salesman with good references; one acquainted with electric lighting stations preferred; state age, experience and salary expected. Address "PERFECTION," care The Electrical World, N. Y.

DYNAMO MAN.—An expert dynamo and station man wants position with large plant; experience in plant of 3,000 h. p. capacity; armature winder; best of references; cut this out and save it if you need a good man; correspondence solicited. Address "DYNAMO MAN," care The Electrical World, N. Y.

WANTED—Agents for The Electrical World and the electrical book publications of the W. J. Johnston Company. Liberal terms in books or cash. Address
W. J. JOHNSTON,
THE ELECTRICAL WORLD,
253 Broadway, New York.

WANTED, AN IDEA.—Who can think of some simple thing to patent? Protect your ideas, they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offer and a list of 200 inventions wanted. Also sample copy of the National Recorder, the largest scientific paper published at the National Capital. Sample copies free.

AGENTS WANTED

in every town and city in the United States, to sell private line and exchange telephones; we manufacture largest line and best telephones in the world; write for particulars.

Electrical Mfg. & Supply Co.,
MANISTEE, MICH.

CAPITAL WANTED.

Well established

AUTOMATIC ENGINE BUSINESS.

Liberal inducements offered.

Address "ENGINE," care The Electrical World, N. Y.

FOR SALE.

The rate for "For Sale" advertisements of forty words or less is one dollar and fifty cents an insertion; additional words three cents each. Remittance should accompany order.

FOR SALE.

ARC DYNAMOS.

One	75	Light	1200	C.-P.	"American-Wood."
"	50	"	1200	"	" "
"	50	"	2000	"	" "
"	35	"	2000	"	" "
"	25	"	2000	"	" "
"	10	"	2000	"	" "
Two	45	"	1200	"	"Excelsior."
"	30	"	2000	"	"
"	35	"	2000	"	"Ball."

DIRECT CURRENT DYNAMOS.

One	100	Light	110	Volt	"U. S."
"	200	"	70	"	"
"	150	"	100	"	"Brush."

ALTERNATING CURRENT DYNAMOS.

Three	1000	Light	"Slattery"	1000 & 2000	Volt.
One	500	"	"T.-H."	1000	Volt.
"	400	"	"	1000	"

ENGINES.

One	10	H.-P.	Vertical "Westinghouse."
"	25	"	" "
"	45	"	Horizontal "Armington & Sims"
"	180	"	" "N. Y. Safety."

Send for list of Transformers and Arc Lamps.

BAECHTOLD & PARKER ELECTRIC CO.,
(At Brooklyn Bridge Entrance.)
79 & 81 Washington St., - BROOKLYN, N. Y.

NOTICE.

An English electrical company incorporated in 1883 (under Acts of Parliament, 1862 to 1880), has opened a department in its London office for the commercial development of European patents relating to

ELECTRICAL INVENTIONS.

Inventors wishing to propose business of this kind are requested to address, in first instance, "Company," care Messrs. Campbell, Solicitors, 17 Warwick Street, Regent Street, London, W.

To Contractors for Electric Lighting.

Office of the
Board of Public Improvements,
St. Louis, Mo., December 15, 1896.

Sealed proposals for lighting with electricity the streets, alleys and public places of the City of St. Louis, north of Keokuk street, for the term of twenty (20) years from January 1, 1900, and for the term from February 17, 1905, to December 31, 1919 for that part of the city south of Keokuk street, will be received at the office of the Board of Public Improvements of the City of St. Louis, Mo., until 12 m. of the

9TH DAY OF APRIL, 1897,

at which hour they will be publicly opened and read, viz.:

Letting No. 5,111. For furnishing electric light from incandescent lamps of 32 candle power, each, and for furnishing electric light from arc lamps of 700 candle-power, each, for lighting streets, alleys and public places.

Approximate number required to be in service on January 1, 1900:

Incandescent lamps, six thousand eight hundred and forty (6,840).

Arc lamps, twenty-nine hundred and twenty-one (2,921).

Deposit required, $10,000.

Proposals must be made on blank forms and inclosed in envelopes furnished by the Board of Public Improvements.

The certificate of the Treasurer of the City of St Louis, that the sum of ten thousand dollars ($10,000) has been deposited in the Treasury, must be inclosed with each proposal.

The right to reject any and all proposals is expressly reserved.

Specifications, form of contract, and map of the part of the city to be lighted on January 1, 1900, may be seen at the office of the President of the Board of Public Improvements of the City of St. Louis.

By order of the Board.
ROBT. E. McMATH,
President.

Attest:
EMORY S. FOSTER,
Secretary.

Second-Hand Machinery in Stock Suitable for Electrical Work.

18-in. Throat Punch for blanking armature discs.
Automatic Armature Disc Notching Press.
60-ton Watson-Stillman Hydraulic Broaching Press.
No. 2 Stiles Punching Press.
No. 3 Stiles Punching Press, geared.
800-lb. Pratt & Whitney Friction Drop Hammer.
1350-lb. Merrill Friction Drop Hammer.
No. 1 Diamond Universal Grinder.
No. 2 Landis Universal Grinder.
No. 1 Garvin Power Miller, with arm.
No. 1½ Garvin Power Miller, without arm.
No. 5 Brainard Power Miller, without arm.
18 in.x16 in x3½ ft. Putnam Planer.
16 in.x12 in.x12 in. Whitcomb Crank Planer.
28 in.x28 in.x8 ft. Putnam Crank Planer.
43 in.x30 in.x8 ft. Powell Planer.
70 in.x16 ft. Horizontal Boring Machine.
13 in.x5 ft. Fox Monitor Lathe.
12 in.x5 ft. Prentice Bros.' Engine Lathe, P. Gib Rest.
13 in.x6 ft. Pratt & Whitney Engine Lathe, R. & F. Rest and Taper.
14 in.x6 ft. Blaisdell Engine Lathe, Raise and Fall Rest.
16 in.x7 ft. Bogert Engine Lathe.
20 in.x10 ft. Prentiss Engine Lathe, C Rest.

We carry a large assorted stock of New Machinery. Send for Lists.

PRENTISS TOOL & SUPPLY CO.,
62-64 So. Canal St., CHICAGO, ILL. 115 Liberty St., NEW YORK.

FOR SALE.

Railway Generators.

Seven M. P., 500, 666 H. P, 550-volt generators with station apparatus.
Three M. P. 200, 266 H. P., 550-volt generators with electric apparatus.
Four Edison 100 K. W, 133 H. P., 500-volt generators with station apparatus.
Four D 62, 80 H. P., 500-volt generators with station apparatus.
Two Edison 60 K. W., 80 H. P., 500-volt generators with station apparatus.
Four M. P. 75, 100 H. P., 500-volt generators with station apparatus.
One armature for 100 K. W. Edison generator.
One armature for D. 62 generator.

Railway Motors.

Twenty G. E. 800 motors.
Twenty W. P. 50, 25 H. P. motors.
Fifteen No. 6 Edison motors.
Twenty F. 30, 15 H. P. motors.
Twenty G. E 800, drum armatures, No. 9 wire, four turns, solid leads.

Stationary Motors.

110-Volt Motors.

From ⅛ to 2 H. P. of different makes. Write for list.

220-Volt Motors.

One 1 H. P. Mather.
One 1 H. P. Queen City.
One 3 H. P. T.-H., oil cup bearings, brand new.
Two 3 H. P. C. & C., brand new.
Two 3 H. P. T.-H., S. O. bearings.
One 3 H. P. Kester, S. O. bearings, with extra armature.
One 3 H. P. Davis, nearly new.
One 4 H. P. Mather.
One 5 H. P. C. & C., brand new.
One 5 H. P. Mather, new commutator.
One 7½ H. P. Edison, S. O. bearings.
One 7½ H. P. Mather.
One 7½ H. P. Kester, S. O. bearings.
One 10 H. P. Kester, S. O. bearings.
One 10 H. P. Mather.
One 12 H. P. C. & C, S. O. bearings.
One 15 H. P. Belknap.
One 20 H. P. Triumph, S. O. bearings.
One 25 H. P. T.-H., first-class condition.
One 25 H. P. T.-H., good condition.
One 3 H. P. Edison, self-oiling bearings.
One 1½ H. P. Robinson-Foster.
One 1 H. P. Eddy, oil cup bearings.
One 3 H. P. T.-H. oil cup bearings.

500-Volt Motors.

One ½ H. P. Crocker-Wheeler.
One ½ H. P. Eddy, brand new.
One 1 H. P. Eddy, brand new.
Two 1 H. P. Ketchum.
Two 1 H. P. Winchenden.
One 2 H. P. Eddy, brand new.
Two 5 H. P. C. & C., brand new.
One 8 H. P., good condition.
One 10 H. P Edison.
One 10 H. P. Lundell.
One 12 H. P. C. & C., S. O. bearings, fine.
One 15 H. P. Triumph.
One 15 H. P. C & C., brand new.
One 20 H. P. Card.
One 20 H. P. Mather.
One 40 H P. C. & C

500-Volt Motors.

One 50 H. P. T.-H.
All motors unless otherwise specified have self oiling bearings and are complete with starting box.

125-Volt Dynamos.

Five 6 K. W. Edison, shunt wound, new.
Five 12 K. W. Edison, shunt wound, new.
Six 15 K. W. Edison, shunt wound, new.
One 15 K. W., 270-lt., shunt wound Edison.
One 20 K. W., 360-lt., 110-volt, shunt wound, Edison.
One 25 K. W. Edison, shunt wound, new.
Two 30 K. W. Edison, compound wound.
Two 30 K. W., 540-lt., T.-H. H. I. dynamos 110-volt compound wound, oil cup bearings, with base frames.
One same as above with new armature.
One 30 K. W. Edison, shunt wound, oil cup bearings, new.
Two 45 K. W. Edison, compound wound.
One 140 lt. C. & C. compound.
One 100 K. W. Multipolar Westinghouse.
One 250-lt. Eddy compound, S. O. bearings.
One 100 K. W. Multipolar Westinghouse.
One 500-lt. Ft. Wayne, "Wood," compound S. O. bearings.
One 700-lt. C. & C. compound, S. O. bearings; speed, 825 R. P. M.; nearly new and very fine.

Arc Dynamos.

One 2-lt., 2,000 C. P., Brush.
One 5-lt., 1,200 C.P., Brush, oil cup bearings.
One 5-lt., 2,000 C.P., Brush, oil cup bearings.
One 20-lt. 2,000 C. P., Brush, oil cup bearings.
One 23-lt., 1,200 C. P., American.
One 25-lt. 2,000 C. P., T.-H. arc.
Five 30-lt., 2,000 C.P., Brush, oil cup bear'gs.
One 30-lt., 2,000 C. P., T.-H., oil cup bearings.
Two 30-lt., 1,200 C. P., T.-H., one spherical one-ring armature, one right hand, other left hand machine.
One 40-lt., 2,000 C. P., "Wood" arc, fine.
One 50-lt., 2,000 C. P., T.-H. arc, fine.
One 50-lt., 2,000 C. P. Schuyler.

Alternators.

One 750-lt., 1,000-volt, Westinghouse shunt wound alternating dynamo, oil cup bearings, complete with exciter and station equipment, mounted on wood.
Two 650-lt. T.-H. A 35, 1,000-volt, compound wound, alternating current dynamos, self-oiling bearings, complete with exciters and station equipment, mounted on slate.

Arc Lamps.

Ten 1,200 C. P. single T.-H.
Twenty 1,200 C. P. single Brush.
Thirty-two 2,000 C. P. T.-H., double.
Forty 2,000 C. P. "Wood," single.

Transformers.

Twenty T.-H. Type E, 40-lt. transformers, 1,000-volt primary, 52 or 104-volt secondary.
Ten 80-lt. Westinghouse step up transformers from 1,000 to 2,000 volts for indoor use.

FRANK RIDLON CO.
180 Summer Street, *BOSTON, MASS.*
New York Agent, CHARLES N. WOOD, 80 Broadway, Room 131.

FOR SALE.

ELECTRICAL APPARATUS.

8-circuit arc, marble switch board, Gen. Electric Co., new.
1 Ammeter, General Electric Co., capacity 1,300 Amp.
5 Belt controllers for American dynamos.
Immediate delivery. Address
WM. M. WOOD, Treasurer,
P. O. Box 3621,
116 Ames Building, Boston, Mass.

For Sale—Electrical Machinery.

One 15 H.P. 220 volt Eddy motor, with new armature.
One 150 light, 110 volt Brush dynamo.
One D 62-500 volt T.-H. railway generator.
One 80 kw., 500 volt Edison " "
One 40 kw., 500 volt Continental railway generator.
Will be sold cheap for cash. Make us an offer.
MICHIGAN ELECTRIC COMPANY, Detroit, Mich.

FOR SALE.

Railway Generators (500 volts).

Two M. P. 500 K.W. T.-H., with instruments.
Two " 270 " " "
Two " 90 " " "
Two " 80 " " "
Two D 62 T.-H. $600.00 each.
Two 150 K. W. Edisons.
Two [illegible] " "
Two 60 " "
One 45 " " $450.00.

Car Motors.

Ten G. E. 800 4 turn (drum armature).
Ten S. R. G. 30's.
Several W. P. 50 armatures, $75.00 each.
Several S. R. G armatures, $40.00 each.

Alternators.

One 120 K. W. 1000-volt Westinghouse toothed armature.
One 75 K. W. 1000-volt 7200 Alt. Westinghouse toothed armature.
One 45 K. W. 1000-volt Westinghouse toothed armature.
Two A 90 K. W. Gen. Electric 2000 volt toothed armature.
Two A 60 1000-volt T.-H. toothed armature.
One A 70 " " " "
One A 35 " " " "
One A 30 " " " "
Exciters and instruments can be furnished with all the above if desired.

Direct Current Lighting Dynamos (110 volts).

Two 100 K. W. Edison central station type.
Two 60 " " " "
Two 45 " " " "
Two 30 " " " "
Two 25 " " " "
One 15 " " " "
One 20 K. W. Jenney new compound self-oiling bearings, $350.00.
Two 300 amp. Westinghouse.
Two 90 amp. Westinghouse compound wound letter type, new.
Two 60 amp. Westinghouse compound wound letter type, new.
One 45 amp. Westinghouse compound wound letter type, new.
One No. 2 Eddy plating dynamo, new.
Besides a number of other and smaller machines.

Arc Dynamos.

Two 65 light No. 8, 10 amp., Brush.
Two 50 light M. D., 10 amp., T.-H., ring armature.
Two 50 light M. D., 10 amp., T.-H., spherical armature.
One 35 light M. D., 10 amp., T.-H., ring armature.
Two 35 light M. D., 100 amp., T.-H., spherical armature.
One 30 light M. D., 10 amp., T.-H., ring armature.
One 100 light 6.8 amp. Excelsior.
One 45 light 6.8 amp. T.-H.
Two 40 light 10 amp. Western Electric.

Arc Lamps.

We have on hand a large stock of T.-H., both double and single 2000 and 1200 C. P. They are as good as new. Exceptionally low prices.

Stationary Motors.

One M. P., 150 H. P., 220-volt Westinghouse.
Two M. P., 125 H. P., 220-volt, Westinghouse.
One M. P., 40 H. P., 220-volt, Westinghouse.
One D 50 K. W., 220-volt, T.-H.
One D 3 " "
One D 2 " "
One 15 H. P., " C. & C
One 5 " " " new.
One 3 " " Jenney, new.
Two 3 " " Sprague.
Two 2 " "
One 2½ " " Wood.
Two 1 " " Crocker-Wheeler, new.
Two ½ H. P., 220-volt, Eddy, new.
One 10 " 500-volt, Edison, new armature.
One 5 H. P., 500-volt, Sprague.
One 3 " "
One 15 " " Westinghouse.
One 2½ " " " new.
One 2½ " " Wood.
One 2 " " T.-H.
One 1¼ " " Crocker-Wheeler,
Two 1 " 110-volt, Sprague.
Two ½ K. W., 110-volt, Edison.
One ¾ H. P., " Eddy.
One ½ H. P., " Perrett.

Every machine guaranteed to be in absolutely first-class condition.

Send for Our Complete List, Just Issued.

We buy outright and take in part payment machinery in good condition of well-known manufacture.

ROSSITER, MacGOVERN & CO., *107 Liberty St., NEW YORK.*

FOR SALE.

ARC DYNAMOS.

1 9-lt., 1200 C. P., Thomson-Houston.
1 18-lt., 1200 C. P., Thomson-Houston.
1 20-lt., 1200 C. P. Excelsior.
4 20-lt., 2000 C. P., Sperry.
1 20-lt., 2000 C. P., Standard.
1 25-lt., 1200 C. P., Sperry.
1 25-lt., 2000 C. P., Excelsior.
2 30-lt., 2000 C. P., Sperry.
1 30-lt., 2000 C. P., Thomson-Houston.
1 30-lt., 1200 C. P., Thomson-Houston.
1 45-lt., 1200 C. P., Sperry.
1 35-lt., 2000 C. P., Thomson-Houston.
1 45-lt., 1200 C. P., Thomson-Houston.
1 45-lt., 1200 C. P., Brush.
2 50-lt., 2000 C. P., Thomson-Houston.
2 60-lt., 2000 C. P., Western Electric.
2 60-lt., 2000 C. P., Wood.
2 65-lt., 2000 C. P., Brush.

500 ARC LAMPS of Standard Makes.

Also Alternators, 110-Volt Dynamos, Motors of All Kinds, Transformers, Instruments and Supplies. **Send for our Monthly BARGAIN SHEET.**

CHAS. E. GREGORY CO., 47-49 S. Jefferson St., Chicago.
We are HEADQUARTERS in Chicago for REPAIR WORK.

FOR SALE—30 W. P. Electric Motors, Form F., General Electric, 220 volts, 30 horse power, practically new, majority never been used; suitable for power, illumination and low voltage car plant by METROPOLITAN RAILROAD CO., Washington, D. C.

FOR SALE.

One 12 x 20 x 12 Westinghouse compound engine, in first-class condition; can be seen in running order at our station; will be sold at very low figure if taken at once. Address MORRIS COUNTY ELECTRIC CO., Morristown, N. J.

Combining Stations in Paterson, N. J., has left the following operative apparatus for sale, which can be delivered within a few weeks.
60 and 100 K. W., 125 Volt bi-polar Edison Dynamos.
60 K. W., 500 Volt bi-polar Edison Dynamos, compound wound.
13 in. x 12 in. and a 16 in. x 16 in. Ball High Speed Engines.
The above apparatus is in perfect order and is operating today.
Address, Paterson Edison Electric Illuminating Co., Paterson, N. J.

BOOKS ON ELECTRICAL SUBJECTS
mailed to any address in the world, **Postage Prepaid,** on receipt of price. Address,
THE W. J. JOHNSTON CO., 253 Broadway, New York.

For other For Sale Advertisements see page xxvi.

PROTECTION GUARANTEED TO ALL PURCHASERS.
NON-INFRINGING.

STORAGE BATTERIES FOR

Central Station Lighting,
Trolley Regulation,
Telephone, Telegraph,
House Lighting.

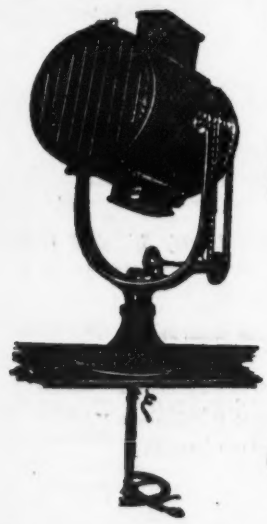
THE ELECTRO-CHEMICAL STORAGE BATTERY CO.

WORKS: BELLEVILLE, N. J.

MAIN OFFICES, NEW YORK,
JOHNSTON BLDG., 34 BROAD ST.

Special Storage Batteries
FOR

Horseless Carriages,
Advertising and Delivery Vans.
Lightest Weight--Highest Efficiency.



The Scott Electric Lamp Co.

ESTABLISHED 1889.

Huntington Search Lights

and

Mirror Lens Projectors.

NOTE.—The Company are sole owners of Patents covering Steering Gear as shown in the cut. The trade is warned against using same without license.

Office and Salesroom,
126 Liberty St., NEW YORK.

Practical Information for

TELEPHONISTS.

By T. D. LOCKWOOD,
Electrician American Bell Telephone Co.

12mo, 192 Pages; Cloth

PRICE, - - $1.00.

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How to Build a Short Telegraph or Telephone Line.
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The Blake Transmitter.
Disturbances Experienced on Telephone Lines.
The Telephone Switch-Board.
A Chronological Sketch of the Magneto-Bell, and How to become Acquainted with it.
Telephone Transmitter Batteries.
Lightning—Its Action upon Telephone Apparatus—How to Prevent or Reduce Troubles Arising Therefrom.
The Telephone Inspector.
The Telephone Inspector—His Daily Work.
The Inspector on Detective Duty.
The Daily Routine of the Telephone Inspector.
Individual Calls for Telephone Lines.
Telephone Wires versus Electric Light Wires.
Electric Bell Construction, Part I.
Electric Bell Construction, Part II.
Housetop Lines, Pole Lines and Aërial Cables.
Anticipation of Great Discoveries and Inventions.

Copies of the above book will be sent by mail, POSTAGE PREPAID, to any address in the world, on receipt of price.

Address,

The W. J. JOHNSTON CO.,

253 Broadway, New York.

NO. 7707 IRON BOX BELL.

FOR SALE.

The complete Manufacturing Plant of H. E. & C. Baxter.

Embracing **Machinery, Special Tools, Patterns, Etc.**, necessary to manufacture their large line of Standard Electrical Goods.

The plant includes a large line of Electrical Bells, among which is their well known **No. 7707 Iron Box Bell.**

As to quality of goods would refer you to any Electrical Supply House in the country. Call on or Address,

James N. Baxter, Assignee,

Bedford, Canton and Division Sts., - - BROOKLYN, N. Y.

OUR AUXILIARY CROOKES TUBES

are the best; longer life, stronger **Rays,** less **energy** required. **Recommended** by the leading **Professors.** **Fully Guaranteed.**

FLUOROSCOPES, SCREENS AND COMPLETE OUTFITS. *WRITE US.*

GREEN & BAUER, THE EXPERTS,

356 Asylum Street, HARTFORD, CONN.

John C. Boss, Pres. & Treas. O. M. Ash. Elec

The Lakon TRANSFORMER.

The Lakon Transformer is built under the famous **GUTMAN TRANSFORMER PATENT,** Each Lamina having but one opening. ("See cut.")

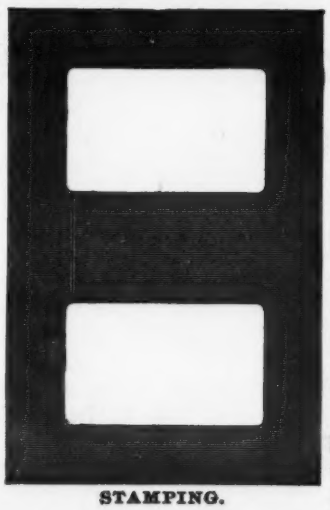
This Insures a Smaller Iron Loss than any other Construction.

The LAKON CO., Elkhart, Ind.

BRANCH OFFICES.

New York City, N. Y.: 136 Liberty Street.
Chicago, Ill.: 1509 Monadnock Block.;
Boston, Mass.. 240 Congress Street.
Minneapolis, Minn.: Elec. Engineering Co.
Los Angeles, Cal.: Machinery Supply Co.
Houston, Tex.: Barden-Sheets Elec. Con. Co.
Toledo, Ohio: Bissell, Dodge & Erner Co.
Jacksonville, Fla.: Johnson, Law & Co.

Address all Correspondence The Lakon Co., 1509 Monadnock Block, Chicago, Ill



STAMPING.

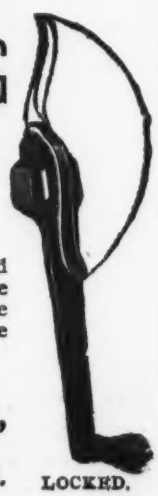
Address all Correspondence The Lakon Co., 1509 Monadnock Block, Chicago, Ill.

UNLOCKED.

THE EDDY SELF-LOCKING WINDLASS.

The most modern and reliable windlass in the market. Adopted by the best engineers in the country.

S. E. WHITEHEAD,
810 Commercial Building,
ST. LOUIS, MO., U. S. A.



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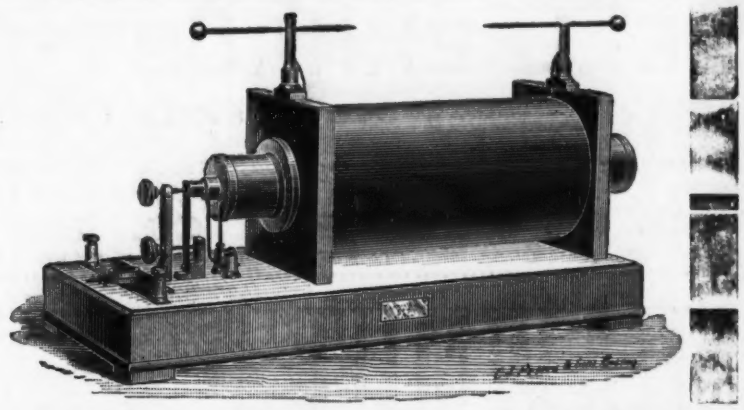

Ruhmkorff Coils For all kinds of X-RAY WORK.

Static Machine Outfits, Crookes Tubes, Fluoroscopes, Photo-Screens, Batteries, and a full line of X-Ray apparatus. Our outfits are the cheapest and best that can be procured.

Send for our new catalogue.

G. A. FREI & CO.,

17 Bromfield Street, BOSTON.

Miniature Incandescent Electric Lamps

MANUFACTURED BY

STANDARD ELECTRIC LAMP and NOVELTY CO.

WRITE FOR CATALOGUE AND PRICES.

248 West 23d Street, . NEW YORK.

TERRA COTTA CONDUIT.

Everlasting, Economical, Efficient.

Made in 2 3 4 6 and 9 Ducts.

McRoy Vitrified Terra Cotta Conduit Is the Best.

Used by Chicago City Railway, Chicago Telephone Co., Detroit Telephone Co., and others. Address, for further information,

JOHN T. McROY, 915 Chamber Com. Bldg., Chicago.

The QUEEN-WIRT

AMMETERS and VOLTMETERS ARE GUARANTEED for PERMANENCY and ACCURACY.

Queen & Co., Inc.

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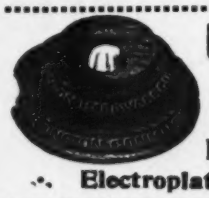

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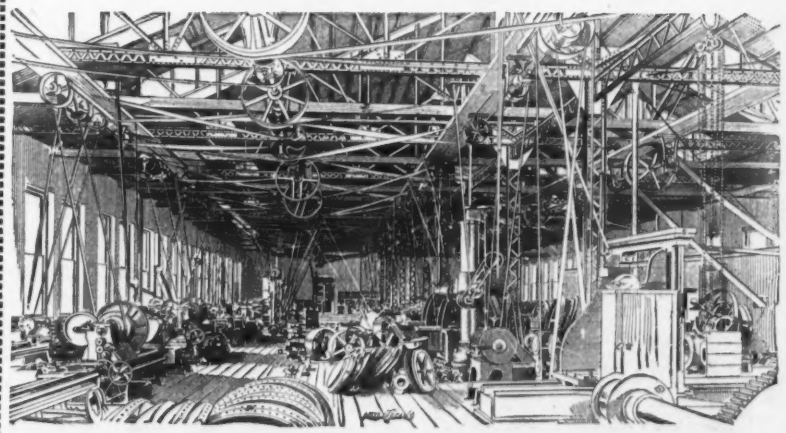

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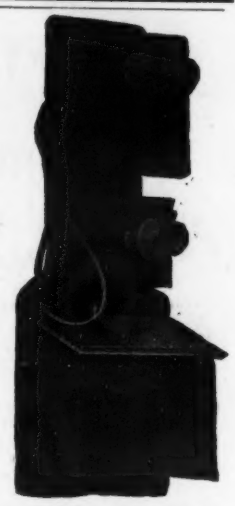

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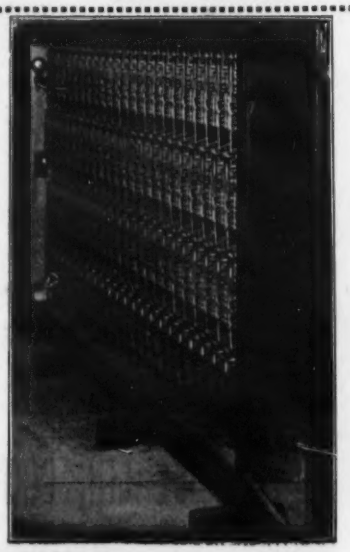

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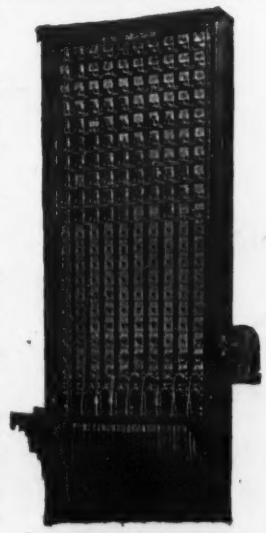

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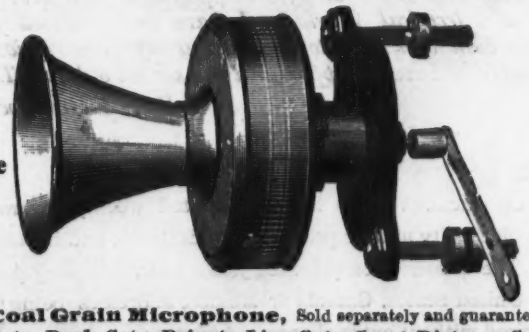

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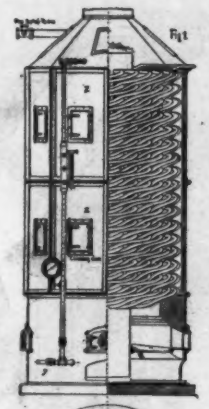

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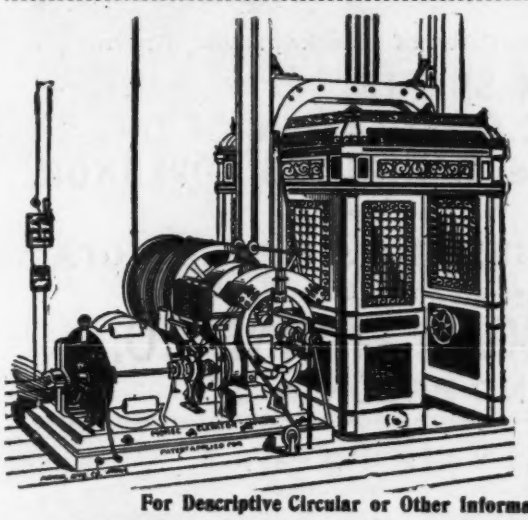

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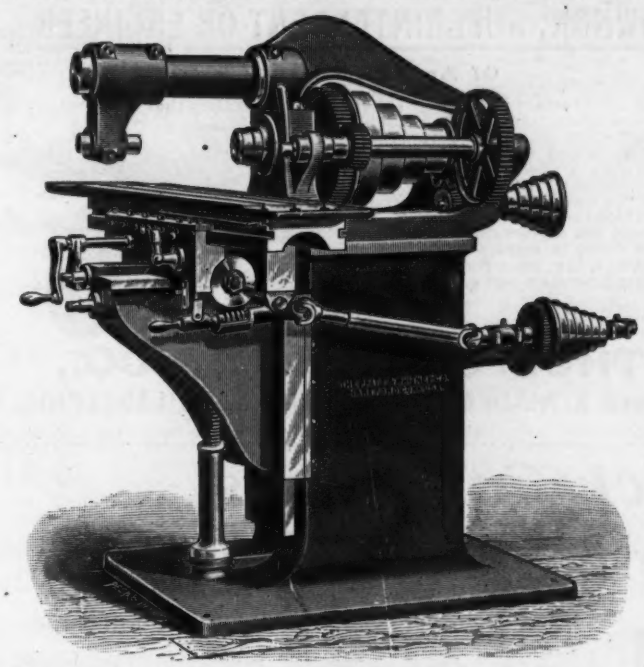

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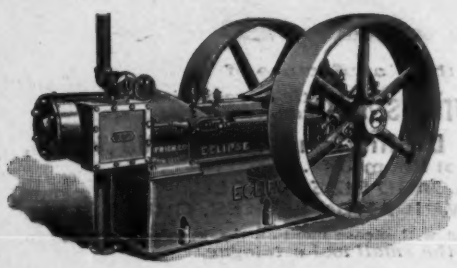

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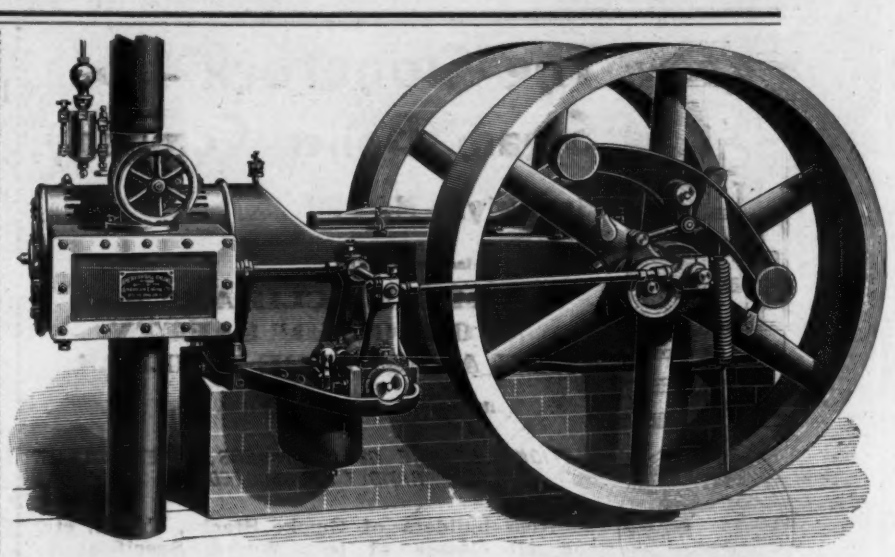

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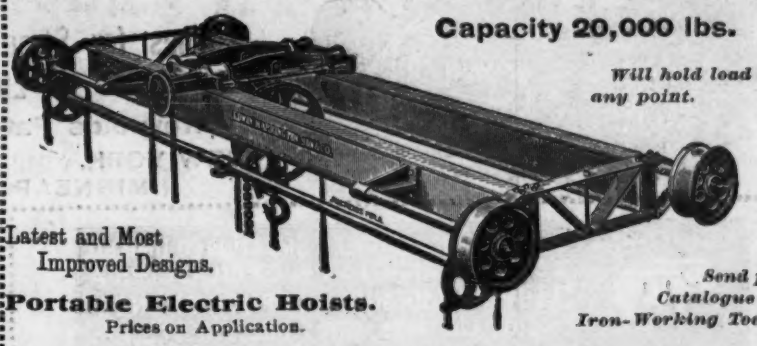

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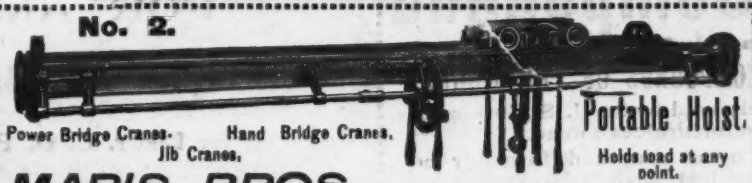

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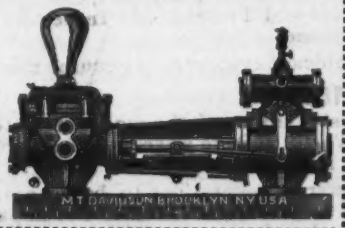

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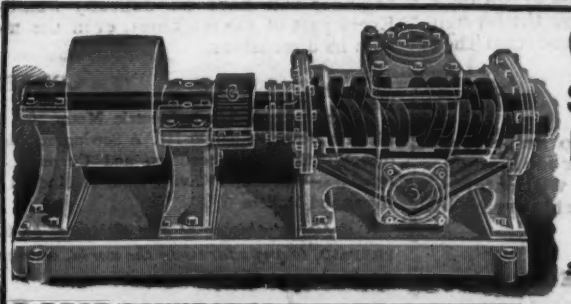

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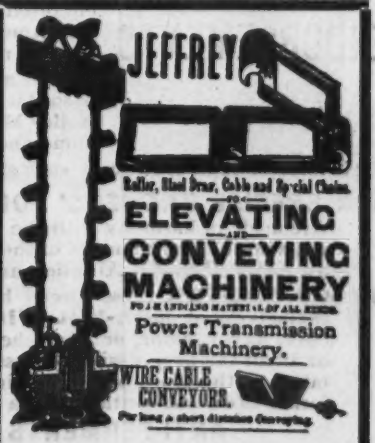

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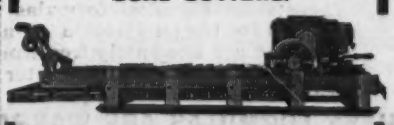

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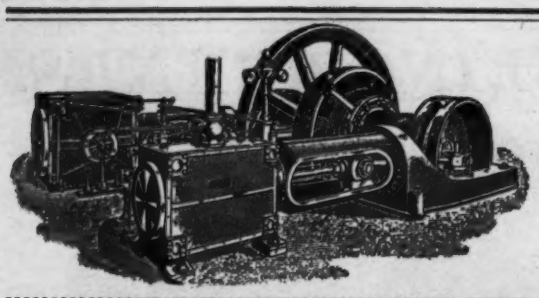

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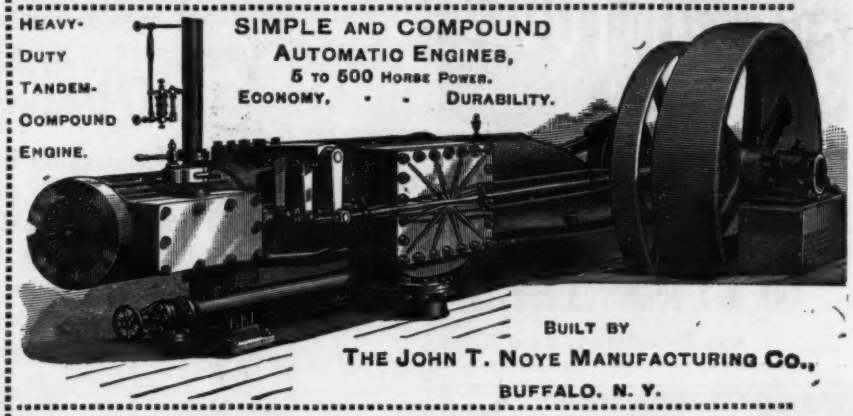

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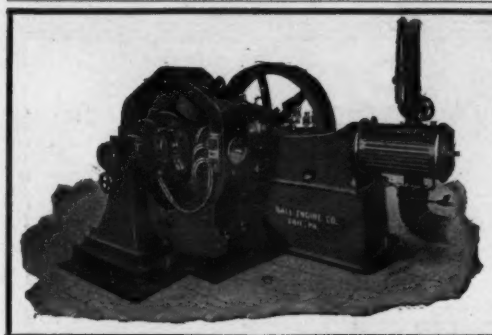

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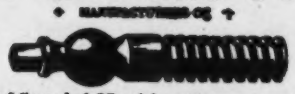

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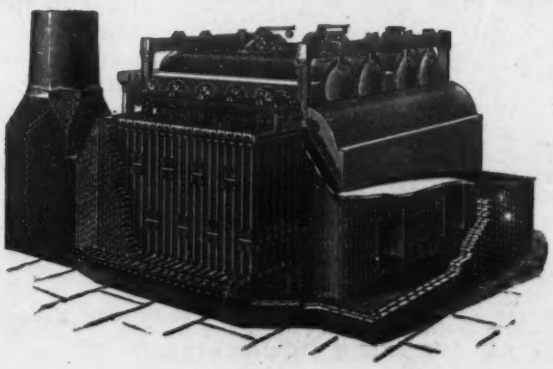

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THE ELECTRICAL WORLD

AN ILLUSTRATED WEEKLY REVIEW OF CURRENT Progress IN Electricity AND ITS PRACTICAL APPLICATIONS

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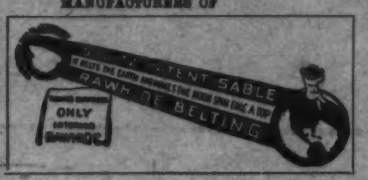

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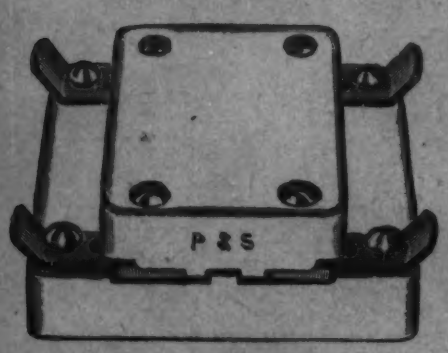

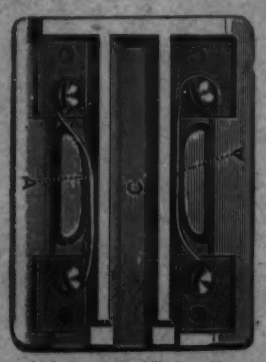

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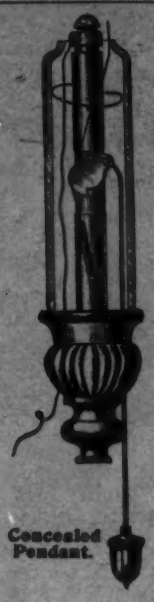

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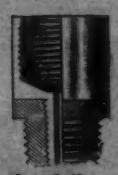
Plain Pendant.

Pendant Argand.



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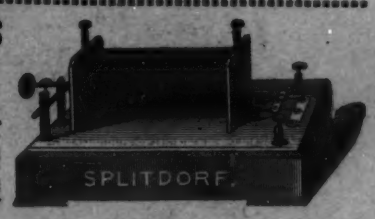

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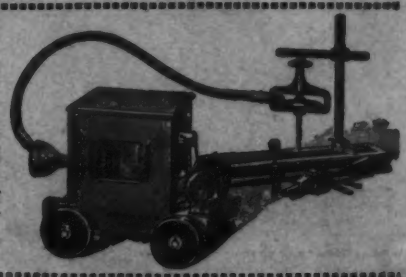

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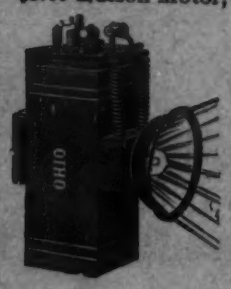

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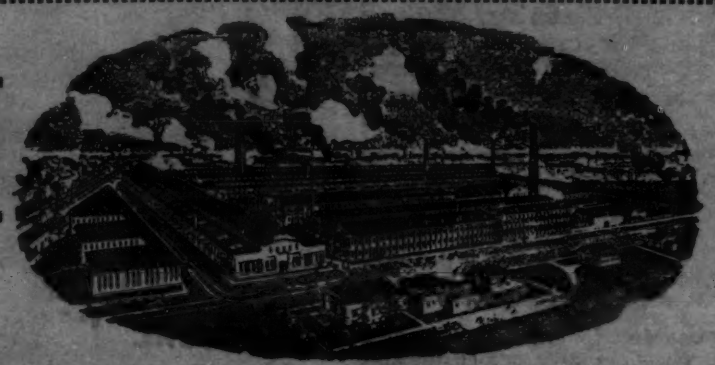

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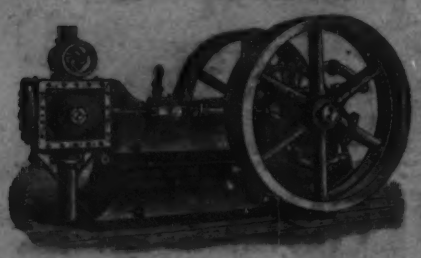

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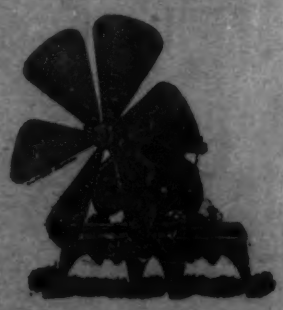

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